AIR FORCE

QUALIFICATION TRAINING PACKAGE (AFQTP)

For

ELECTRICAL SYSTEMS

(3E0X1)

MODULE 19

AIRFIELD LIGHTING SYSTEMS

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

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AIRFIELD LIGHTING SYSTEMS

Career Field Education and Training Plan (CFETP) references from 1 Apr 97 version.

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AIR FORCE QUALIFICATION TRAINING PACKAGES
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INTRODUCTION

Before starting this AFQTP, **refer to and read the "Trainee/Trainer Guide" located on the AFCESA Web site** http://www.afcesa.af.mil/. This guide will be found at each AFS's AFQTP download page.

AFQTPs are mandatory and must be completed to fulfill task knowledge requirements on core and diamond tasks for upgrade training. ***It is important for the trainer and trainee to understand*** that an AFQTP ***does not*** replace hands-on training, nor will completion of an AFQTP meet the requirement for core task certification. AFQTPs will be used in conjunction with applicable technical references and hands-on training.

AFQTPs and Certification and Testing (CerTest) must be used as minimum upgrade requirements for Diamond tasks.

MANDATORY minimum upgrade requirements:

Core task:
AFQTP completion
Hands-on certification

Diamond task:
AFQTP completion
CerTest completion (80% minimum to pass)

Note: *Trainees will receive hands-on certification training when equipment becomes available either at home station or at a TDY location.*

Put this package to use. Subject matter experts under the direction and guidance of HQ AFCESA/CEOT revised this AFQTP. If you have any recommendations for improving this document, please contact the Electrical Career Field Manager at the address below.

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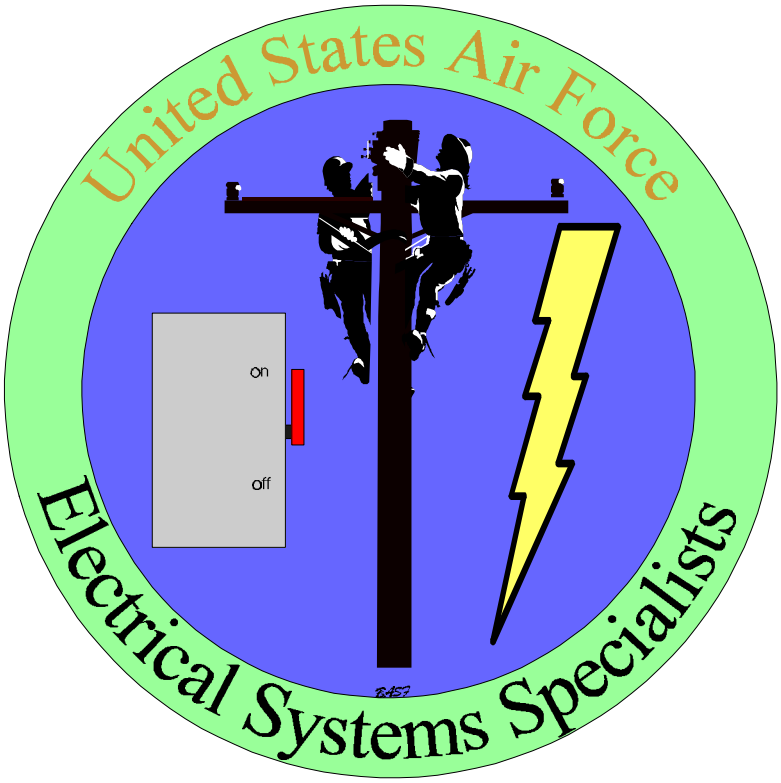


INSTALL

MODULE 19 AFQTP UNIT 2

AIRFIELD LIGHTING SYSTEMS COMPONENTS (19.2.1.)

AIRFIELD LIGHTING SYSTEM COMPONENTS

Task Training Guide

STS Reference Number/Title:	19.2.1. – Airfield lighting systems, install airfield lighting systems components
Training References:	• T.O. 35F8-14-1 • AFI 32-1064, Electrical Safe Practices • CDC 3E051, Set B, Vol. 3
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• High intensity approach and condenser discharge light unit • Runway Marker /Approach Slope Indicators • Runway Lighting Fixture • Clamp on Ammeter • Common Hand tools • Multi-meter
Learning Objective:	• Given equipment, install airfield lighting systems components
Samples of Behavior:	• Follow approved methods to install airfield lighting systems components • Know safety requirements associated with installing airfield lighting systems components
Notes:	
• To successfully complete this element, the trainee must be able to identify procedures to install airfield lighting system components with no major discrepancies that which classifies the installation as unserviceable or against FAA standards. • Any safety violation results in an automatic failure.	

AIRFEILD LIGHTING SYSTEM COMPONENTS

Background: The high-intensity lighting system is the basic type of installation used by the Air Force. To keep this system working properly and efficiently, constant current regulators, IL transformers, and control systems are utilized.

Control components.

- It would be a waste of Air Force resources to keep personnel on hand at the airfield lighting vault in order to operate the airfield lighting system. The control components provide remote operation capabilities of airfield lighting systems. Giving the control tower these remote capabilities, they can control the lighting systems. In order to control the airfield lighting system from a remote position, certain components are required.

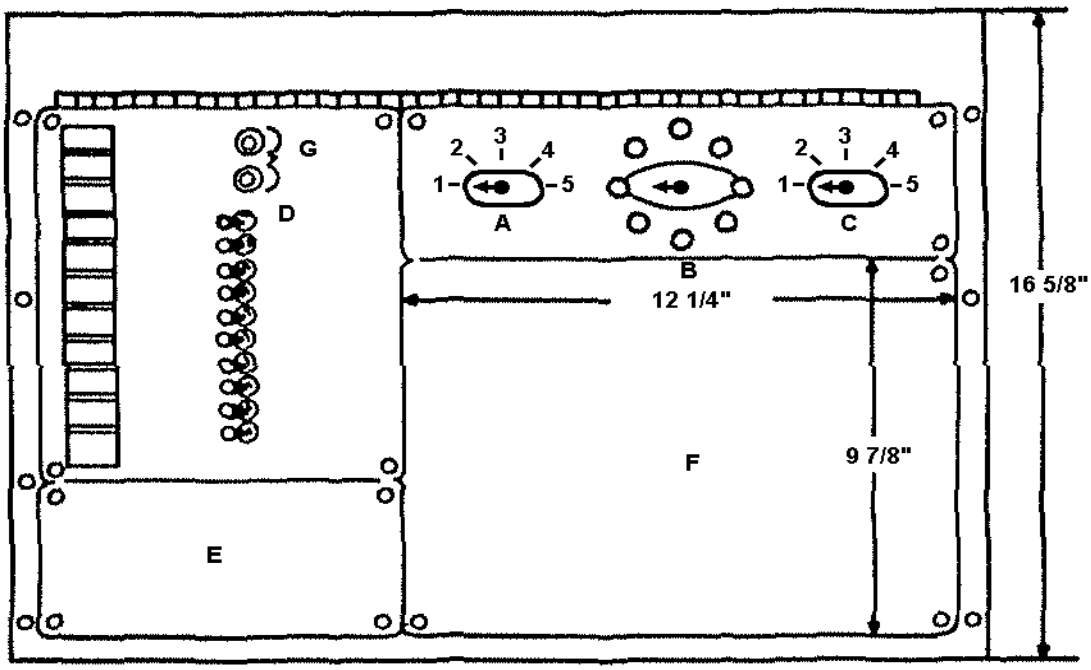
- The control system for airfield lighting consists of control panels, relaying equipment, accessories, and circuits to remotely control circuits. These circuits energize, de-energize, select lamp brightness, and otherwise control the various airfield lighting circuits in accordance with operational requirements. Runway lighting controls are an integral part of the airfield lighting system. Consequently, the design criteria described in the following paragraphs for runway lighting controls apply in general to the design for the control of other airfield lighting systems.

MA-1 Panel.

- For control at the remote location, the type MA-1 control panel is used. The panel includes control switches for all airfield lighting components. This panel houses the complete controls for the entire airfield lighting system. The MA-1 control panel is contained in a small metal cabinet. The cabinet contains two push-to-reset circuit breakers, toggle switches, and rotary selector switches. The rotary selector switch used is a five-position switch for adjusting the brightness of runway lights. (Figure 1).

Control cable.

- The control cable for airfield lighting is a seven conductor cable, 600-volt, sheathed cable. One conductor (black) is a No. 12 AWG and the remaining conductors are No. 18 AWG. The No. 12 is used as the hot lead and the No. 18conductors are used to carry the control voltage from the tower MA-1 panel to the transfer relay panel or from the airfield lighting vault MA-1 panel to the transfer relay panel.



LEGEND
A. RUNWAY BRIGHTNESS SWITCH
B. RUNWAY SELECTOR SWITCH
C. APPROACH LIGHT BRIGHTNESS SWITCH
D. LIGHTING CIRCUITS ON/OFF TOGGLES
E. CARD HOLDER (INSTRUCTIONS)
F. FACSIMILE OF AIRFIELD WITH TAXIWAY SWITCHES
G. CIRCUIT BREAKERS PUSH-PULL

Figure 1, M A-1 Control Panel.

Transfer switch.

- There are two locations at which airfield lighting is remotely controlled. The primary location for remote control is the cab of the control tower. The alternate or secondary remote control location normally will be in the airfield lighting vault. Only one remote location can be in control at any given time. In order to swap location of control, a transfer switch is used. The switch is a single-pole, single throw switch. That means that there is one source of power and only one place to send the power, the transfer relay coil. The transfer relay is spring loaded so that the contacts that energize the tower MA-1 panel are closed when no power is flowing to the relay. When the transfer switch is closed (in the vault position) the relay energizes, pulls in the second set of contacts energizing the vault MA-1 panel, and opening the first set of contacts that feed the tower MA-1 panel causing it to become de-energized. This switch can only be in the tower position or the vault position, and only one MA-1 panel can be energized at a time. (Figure 2).

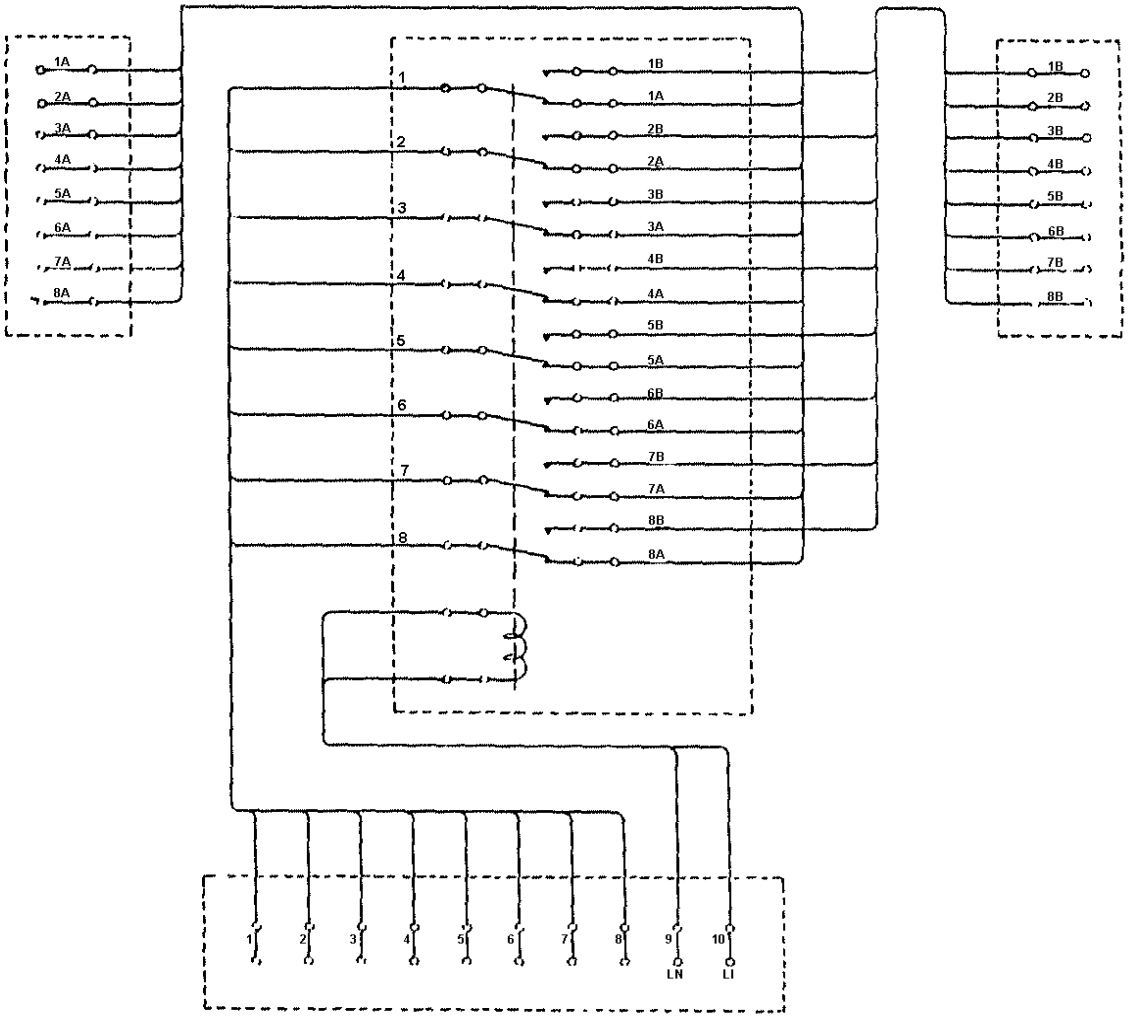


Figure 2, Transfer Relay Cabinet Schematic Wiring Diagram.

Transfer relay panel.

- The transfer relay is used to switch the system control from the tower to the vault or from the vault to the tower. The transfer relay consists of eight-pole, double-throw transfer assembly units. The transfer switch actuates these units. Figure 3 contains the schematic drawing of the transfer relay cabinet.

Circuit breaker panel.

- The circuit breaker panel is the local source of 120 and 240 volt ac power for the low burden pilot relays, low voltage regulators, lights, and any other 120/240 volt system or vault requirement.

Pilot relay panel.

- A 120-volt system utilizing low burden pilot relays is used because of the distance between the control tower and the vault at many airfields. In this type of control system, the switches on the MA-1 control panel actuate the power switches, contactors, and relays controlling the regulators and transformers supplying the airfield lighting circuits. A general description of the control system will help clarify the intricate working of the controls. The low burden pilot relay is designed to operate at a wide range of voltages lower than the designed 120-volt ac rating. The pilot relay can be actuated at voltages from 50 to 120 volts AC, which compensates for the voltage drop from the tower to the vault. This voltage drop is due to the excessive distance between the tower and the vault control locations. The whole purpose of the low burden pilot relay is to provide 120 volts to the regulators. The No. 12 AWG wire carries 120 volts to the tower. The six No. 18 wires carry a voltage, due to the resistance in the wire caused by the long distances, somewhere between 50 and 120 volts back to the vault to operate the low burden pilot relays. When the low burden pilot relays operate, they supply the fresh 120 control volts to the regulators' brightness step relays. See figures 3 and 4 for the wiring diagram of the low burden pilot relay equipment cabinet and connections.

Constant current regulators (CCR) low voltage.

- Low voltage regulators have either fixed or variable outputs. The fixed output regulator is used for lighting circuits that require a constant brightness such as some taxiway, distance marker, and obstruction lights. The low voltage variable output regulator has a seven-position switch that allows for different amperages to be applied to the circuit. The positions include remote, off, and the five brightness steps. The variable output regulator is used for lighting circuits that require different brightness settings due to changing weather conditions. Examples of the circuits are runway, approach, threshold, and approach slope indicator lights. Low voltage regulators may have an input of voltages ranging from 208 to 277 VAC, as well as a newer type with a 480 volt input, all which may have max output of 6.6 amps or 20 amps maximum constant current output.

NOTE:
Airfield regulators are rated by their maximum wattage output in kilowatts, maximum output amperage, and input voltage.

Note: Each terminal block connection will have a separate conductor connected to it, not as it appears that they are not all connected together. They are bundled together for neatness of appearance

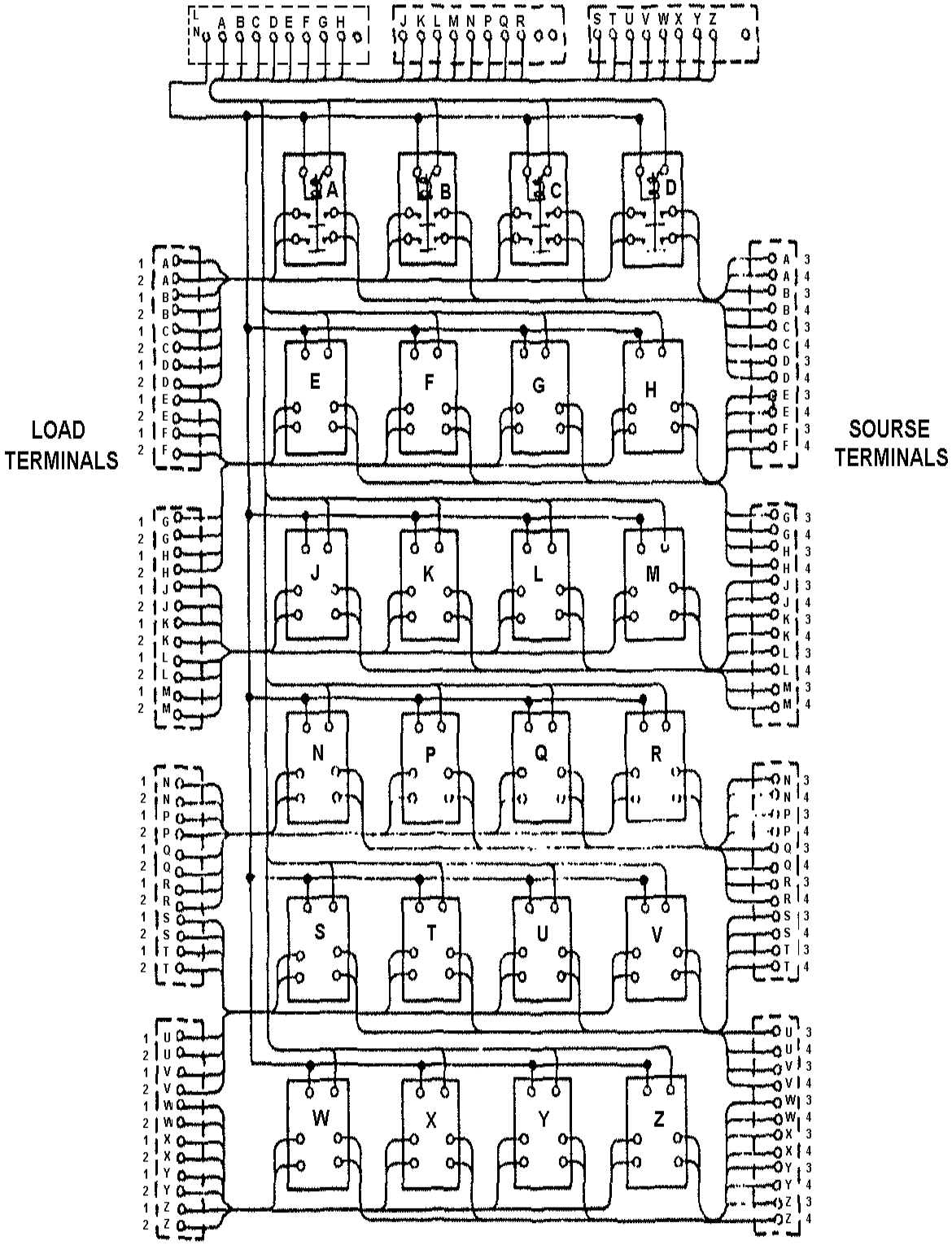


Figure 3, Pilot Relays Schematic Wiring Diagram

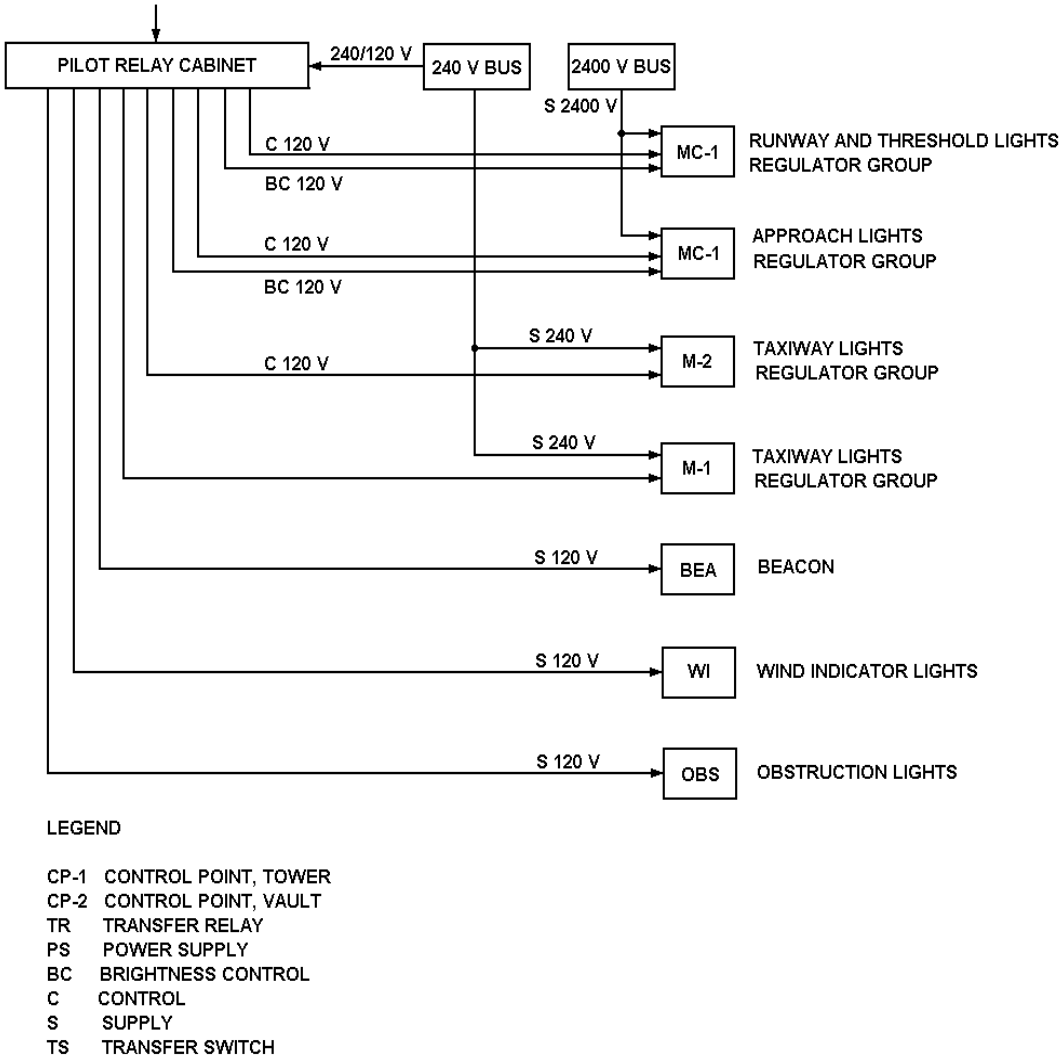


Figure 4, Airfield Lighting Control System

Constant current regulators (CCR) high voltage.

- High voltage regulators have an input of 2400 VAC and have maximum output amperage of 20 amps or 6.6 amps maximum depending on the type of regulator being used. High voltage CCRs have a variable output of five brightness steps controlled by a seven-position switch. The military is presently moving away from high input voltage regulators and are replacing them with regulators which require an input of 480 volts, a safer, lower voltage. These solid state constant current regulators may have an output amperage of either 6.6 maximum or 20 amps maximum. They may be fixed or they may have a five or seven position variable amperage selector to control brightness. The type of regulator used depends on the airfield lighting requirements.

Selecting constant current regulators.

- When a regulator is initially selected the type and amount of lamps in the circuit must first be considered. Emergency loading and connections must also be considered before a regulator can be chosen. To determine how many lamps can be put on a regulator, take the wattage of the lamp and multiply it by the number of lamps in that circuit. This will give the total wattage of that circuit. This wattage must not exceed the maximum wattage of the regulator. Regulators do break down from time to time. Because of this, emergency connections may need to be made. The possibility of additional load is also considered during the selection process. Constant current regulators are loaded to not less than 50% and not more than 100% of their maximum KW output. A regulator will be loaded somewhere in between these two points in the event that an emergency connection is required.

Airfield lighting cable.

- The cable used is No. 8 stranded copper and may have either neoprene rubber or XLP insulation with a5 KV insulationvalue. Airfield lighting usually uses a series circuit fed from a lighting vault.
- All cables are run underground and may be direct buried for temporary installation, installed in concrete encased duct, or in direct buried duct.
- Concrete encased duct or rigid steel conduit is used under areas already paved.
- Provide a continuous counterpoise of No. 4 AWG, bare stranded, copper wire, over the entire length of all primary circuits supplying airfield lighting.

Isolating transformers (IL).

- One characteristic of a series circuit is that when one lamp burns out, all the lamps in the circuit go out. To avoid this problem with series circuits, an isolating transformer is used for each fixture in the circuit, thus isolating each lamp from the circuit to ensure continuous operation and to eliminate the hazard of exposing personnel to the series circuit high voltage.

- IL's are also used to match circuit amperage to amperage of the bulb and to match transformer capability to the wattage of the bulb. Therefore, many different sizes of IL's are used. There are three types of IL transformers: step up, step down, and one-to-one. These transformers work on the same principles as distribution transformers--mutual induction. Isolating transformers are rated in wattage, input amperage, and output amperage.

Fixtures.

- Airfield fixtures use pre-focused bulbs, lenses, and color filters. Fixtures are designated either as elevated or semi-flush and by the number of directions they shine. The directions are Uni-directional (light shines in only one direction), bi-directional (light shines in two directions), and omni-directional (light shines in all directions).

To perform the task, follow these steps:

Installation procedures control components.

Step 1: The installation of control components has to meet Federal Aviation Administration (FAA) requirements and Air Force requirements. To meet these requirements, it is necessary to consult each organization's specifications. The FAA has published guide specifications for installation of airfield lighting systems. FAA guides and specifications come in two forms: FAA circulars and FAA-C specifications. Where those guides are in conflict with AF requirements, the AF requirements will take precedence. The AF specification for airfield construction is covered in AFR 88-14 and AFR 88-15.

Installation procedures constant current regulators.

- Airfield regulators are normally kept in an airfield lighting vault, but some are weather sealed so they may be used out in the open for contingency operations, very small runways, or in case of emergency.

SAFETY:
WHEN WORKING AROUND CONSTANT CURRENT REGULATORS, CARE MUST BE TAKEN BECAUSE OF THE HIGH VOLTAGES PRESENT. TWO QUALIFIED SPECIALISTS MUST BE PRESENT WHENEVER WORK IS DONE ON REGULATORS

Step 1: Perform a pre-installation check.

- Before a new regulator can be put into service, a pre-installation check must be made. If instructions are provided with the regulator, they will be used. First, the regulator must be taken out of the crate and any packing material must be removed.
- Check the regulator for obvious damage.
- Check the oil level and if any seals appear damaged or disturbed, the regulator must be pressure tested and the oil di-electrically tested.
- Check bushings for cracks, chips, etc.
- Check the relay compartment for missing parts and tight connections.
- After all of this is checked, the regulator is ready to be installed.

Step 2: Position constant current regulator.

- Place regulator on a surface or structure capable of supporting its weight. Due to its heavy weight, it may be necessary to move the regulator into position near the vault door with a forklift or the line truck.

NOTE:
Be sure not to damage the regulator case when moving it.

Step 3: Connect constant current regulator.

- Securely ground the regulator tank using a copper conductor that is at least equivalent in diameter to the maximum line conductor and at least a No. 6 AWG wire.
- Ensure the input and control circuits are de-energized and tagged.

- Connect output leads to H1 and H2, then connect the input leads to X1 and X2. Finally, connect the control voltage to the appropriate relay.

NOTE:
Before turning over control of the regulator to the tower, it is wise to perform an operational check to make sure it is working.

SAFETY:
WHEN WORKING AROUND CONSTANT CURRENT REGULATORS, CARE MUST BE TAKEN BECAUSE OF THE HIGH VOLTAGES PRESENT. TWO QUALIFIED SPECALISTS MUST BE PRESENT WHENEVER WORK IS DONE ON REGULATORS.

Step 4: Replace damaged constant current regulator.

Ensure circuit is off at the MA-1 panel
Ensure regulator switch is in the off position

- De-energize input voltage.
- De-energize control voltage.
- Check for voltage and current flow.
- Block and tag source.
- Disconnect X1 and X2.
- Ground input leads.
- Disconnect and mark control leads.
- Isolate circuits (disconnect H1 and H2, tag, and ground these bushings).
- Remove regulator.
- Follow normal installation procedures.

NOTE:
Although all of the steps may not have to be done, notifying the tower and isolating the circuit must be done before most work can be accomplished.

NOTE:
The wattage and output amperage must match the lamp, and the input amperage must match the circuit amperage.

Installation procedures isolating transformers.

- Before installing an IL transformer, you must make sure the amperage rating is the same as the output amperage of the regulator.
- Before installing an isolating transformer, be sure to de-energize, tag, and ground the circuit.

SAFETY:
WHEN WORKING ON THE SECONDARY SIDE OF AN ENERGIZED ISOLATING TRANSFORMER, YOU SHOULD BE VERY CAREFUL, BECAUSE THE VOLTAGE WILL RISE EXTREMELY HIGH IF THE SECONDARY SIDE IS OPEN. CARE MUST BE TAKEN WHEN DISCONNECTING THE IL TRANSFORMER. SERIOUS INJURY CAN OCCUR IF CIRCUIT IS ENERGIZED DURING REMOVAL OR INSTALLATION OF THE IL TRANSFORMER

Step 1: Isolate Circuit.

- Before removing or installing an isolating transformer, be sure to isolate the circuit by de-energizing, tagging, and grounding the circuit.

Step 2: Connect Primary Leads.

- Reconnect the primary leads by inserting the male prong into the female receptacle. Be sure to slightly bend the connector kit while you are pushing the plug and receptacle together to let any air trapped inside to escape.

NOTE: If you don't allow the air to escape, it could force the plugs apart allowing an incomplete union. This would result in total circuit failure. Be sure to always "burp" the plug. Don't forget to connect both the primary input and primary output side of the IL.

Step 3: Connect Secondary Leads.

- Like the primary leads, you will need to plug the secondary male and female plugs together. The male side of the plug has two prongs; one has a larger diameter than the other. The female receptacle also has two different size holes that are the same size as the male prongs. This means that there is only one way that the plug can go together.

NOTE:
Again, when connecting these leads, be certain to work as much air as possible out of the connection.

Step 4: Tape Connectors.

- Wrap the connectors with two half-lapped layers of vinyl plastic tape to prevent the connectors from separating and to keep moisture or dirt from entering the plug.

NOTE:
Additional controls are required where centerline, touchdown zone, VASI, etc. are provided.

Install elevated fixtures

- All elevated light fixtures are lightweight and of a frangible (fragile or easily broken) construction to minimize damage to aircraft when hit. Besides aircraft, lawn mowers, snowplows, and trucks depending on their location may also hit lighting fixtures. Also, bulbs will burn out and IL transformers will go bad. The following procedures are for the installation of an elevated light fixture and associated equipment:

Step 1: Notify tower.

Step 2: Isolate circuit.

Step 3: Loosen setscrews on the base of the fixture.

NOTE:
Procedures may vary with each different type of light unit but most fixtures are mounted on a breakaway coupling using set screws on the base of the light fixture.

Step 4: Plug fixture into the female secondary receptacle of the IL

Step 5: Secure the secondary side of the IL by screwing the breakaway coupling into the fixture base plate.

Step 6: Inserted the base of the fixture over the coupling.

Step 7: Tighten the set screws into the coupling.

Step 8: Re-energize the circuit.

Step 9: Notify the tower.

Install semi-flush fixtures.

- The semi-flush light fixture is sturdier than the elevated light fixture but is still subject to some damage. Semi-flush fixtures will receive damage from numerous landings of aircraft and from snowplows during snow removal operations. Light bulbs and IL transformers will also burn out. The following procedures are for installation of the semi-flush light fixture.

Step 1: Notify tower.

Step 2: Isolate circuit.

NOTE:
Most semi-flush fixtures attach to a metal canister buried in the ground. This canister is approximately the diameter of a five-gallon water jug and about three feet deep.

Step 3: Secure a slip ring to the canister.

NOTE:
The slip ring is used to align the fixture with the centerline and other fixtures in the system as required to illuminate the airfield.

Step 4: The bulb inside the fixture is attached to a set of wires using u-shaped solder-less connectors held to the bulb with screws.

Step 5: The other end of the wires has a molded 2 prong male plug that fits into the female receptacle of the IL transformer.

Step 6: Re-energize the circuit.

Step 7: Notify the tower.

Review Questions
for
Airfield Lighting Systems Components

Question	Answer
1. Control components provide remote operation capabilities of airfield lighting.	a. True b. False
2. What are the locations of the primary and secondary control points of the airfield lighting control system?	a. Cab of control tower and electric shop. b. Base operations and airfield lighting vault. c. Cab of control tower and airfield lighting vault. d. Base operations and electric shop.
3. What compensates for the voltage drop from the tower to the vault?	a. Low burden pilot relay b. Transfer relay panel c. MA-1 control panel d. Constant current regulators
4. Name the two inputs of a constant current regulators used in airfield lighting.	a. HI and H2 b. X1 and X2 c. H1 and X1 d. H2 and X2
5. What are constant current regulators rated by?	a. Maximum wattage output in kilo-watts b. Maximum output amperage c. Input voltage d. All of the above
6. What prevents airfield lighting series circuits from going out when one lamp burns out?	a. Constant current regulators. b. MA-1 panels c. Isolating transformers d. Airfield lighting fixtures
7. What is the purpose of the slip ring in the semi-flush light fixture?	a. Prevents canister from sliding. b. Provides easy access to components. c. Gasket between fixture and canister. d. Aligns the fixture with the centerline.

AIRFIELD LIGHTING SYSTEMS COMPONENTS

Performance Checklist		
Step	**Yes**	**No**
1. Did the trainee perform a pre-installation check on the regulator?		
1. 2. Did the trainee properly isolate the constant current regulator?		
2. 3. Did the trainee properly connect the regulator?		
3. 4. Did the trainee properly install an isolating transformer?		
5. Did the trainee tape the connection on the I.L. transformer?		
6. Did the trainee properly install an elevated fixture?		
7. Did the trainee properly install a semi-flush fixture?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

MAINTAIN AIRFIELD LIGHTING SYSTEMS

MODULE 19 **AFQTP UNIT 4**

CONSTANT CURRENT REGULATOR (19.4.1.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

CONSTANT CURRENT REGULATOR

Task Training Guide

STS Reference Number/Title:	19.4.1. – Airfield lighting systems, maintain airfield lighting systems constant current regulator
Training References:	• T.O. 35F8-7-1 • AFI 32-1064, Electrical Safe Practices • CDC 3E051, Vol. 3B • TO 35F8-6-1 • TO 35F8-10-12 • TO 35F8-14-1 • TO 35F8-14-4 • TO 35F8-14-11 • TO 35F8-14-12 • TO 35F8-14-14 • TO 35F8-14-22 • TO 35F8-14-24 • TO 35F8-19-1 • TO 35F8-19-4
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Clamp on Amp meter, Common Handtools, Personal protective equipment
Learning Objective:	• Given equipment, maintain a constant current regulator
Samples of Behavior:	• Follow approved procedures to maintain a constant current regulator • Know safety requirements associated with maintaining an airfield lighting constant current regulator
Notes:	
• Any safety violation is an automatic failure. • Trainer will explain local conditions and characteristics of their particular airfield lighting system, introduce local operating instructions and utilize all technical orders and commercial publications.	

CONSTANT CURRENT REGULATOR

Background: The constant current regulator is designed to regulate the intensity of airport runway lights within the designed range from min. to max brightness as required for aircraft operations under various conditions of visibility. Keep in mind there are different types of regulators operating from different voltages. The lower voltage type regulators are supplied with primary power from the circuit breaker panel in the vault. The higher voltage regulators are supplied from a high voltage bus bar in the vault through a primary cutout. Control power for both types of regulators is supplied from the circuit breaker panel through the low burden pilot relays.

This training guide will help you become familiar with maintenance schedules and basic procedures that can be applied to most all regulators even with technologically advanced (solid-state) regulators that may already be installed at some bases. If manufactures maintenance recommendations are more stringent than the ones listed below follow those guidelines as well. Insure that these standards are maintained, in the publication's library, and are made available for all maintenance personnel.

A minimum of two qualified personnel must be present before any maintenance can be performed on a constant current regulator. Also, the control tower must be notified that work is being performed and if the regulators are to be isolated or troubleshooting is required take control of the airfield vault. After the tower gives you permission and control of the airfield circuits is in the vault, you will be able to isolate the regulator.

All the components of the airfield lighting system work together to form a reliable method of providing a visual references for aircraft. But this system is only as reliable as the maintenance it receives. If you never inspect or test your counterpoise system, your first indication that it is in need of repair could be the unpleasant sensation of current passing through your body. Scheduled preventive maintenance is preferable to emergency maintenance after the system fails. So, perform your recurring maintenance on the counterpoise and constant current regulators. If you keep these systems in good shape, you won't have many unexpected failures.

Equipment needed. The most valuable piece of equipment any person can have is carried around on top of your shoulders, the brain. Whenever you are performing tasks that have the potential of being dangerous--think. THINK before you start the job and during each phase of the job.

Other items that will be invaluable in performing regular maintenance are: the clamp-on ammeter, voltmeter with high voltage attachment, rubber gloves, insulated stool, and cleaning supplies. Where measurement of current is called for, do not use the ammeter on the face of the regulator. This meter does not have the accuracy required for these measurements. Use a clamp-on ammeter, or another similar set up. The MM-1 Test Set contains all the meters that you need to perform regulator maintenance.

Intervals of Maintenance (Frequency). The recurring maintenance program for regulators includes items that are maintained daily, monthly, and annually (Table 1).

- Daily maintenance consists of checking all control components for proper operation. The personnel that work in the control tower test the operation of the airfield lights at each shift change. However, their quick test of the lights is not as thorough as the one you perform.
- Monthly checks include recording the input voltage, output current, and load on the regulator.
- Annually, make a comprehensive visual inspection and an oil test while the regulator is de-energized. After re-energizing the regulator, make short-circuit and open-circuit tests.

MAINTENANCE REQUIREMENT CHECKLIST

Table 1. Recurring Work Program Schedule for Constant Current Regulators

	D	M	A	U
1. Check control circuits on all brightness steps	X			
2. Check input voltage and current		X		
3. Check the regulator load		X		
4. Check output current on each brightness step		X		
5. Check relays, wiring, and insulation			X	
6. Check dielectric strength of cooling oil (if used)			X	
7. Perform short circuit test			X	
8. Perform open-circuit test (only on regulators with open-circuit protective devices)			X	
9. Clean rust spots and paint as necessary				X

LEGEND A = Annually, D = Daily, M = Monthly, U = Unscheduled

Maintenance Procedures:

Items to be checked while energized.

- Check daily, all control equipment for proper operation. Check each remote control switch on each brightness step. Perform these other tests recommended by the Recurring maintenance plan (RMP) while the regulator is energized.

SAFETY:
ANYTIME YOU ARE WORKING IN THE VAULT, THE POSSIBILITY EXISTS THAT YOU MAY CONTACT AN ENERGIZED PIECE OF EQUIPMENT. TO PREVENT A HAZARDOUS SITUATION, TAKE A LITTLE EXTRA TIME AND ISOLATE ANY EQUIPMENT THAT IS IN YOUR IMMEDIATE WORK AREA. WEAR YOUR PERSONAL SAFETY EQUIPMENT

SAFETY:
A SERIES CIRCUIT CONNECTED ACROSS A 50 KW, 20 AMPERE REGULATOR MAY HAVE AN OPEN-CIRCUIT VOLTAGE OF 3,500 VOLTS. HOWEVER, THE MOMENTARY SURGE BEFORE THE OPEN CIRCUIT PROTECTION DEVICE ACTUATES WILL BE MORE THAN THIS. THEREFORE, ONLY QUALIFIED AND AUTHORIZED PERSONNEL MAY PERFORM THE SHORT-CIRCUIT TEST, OPEN-CIRCUIT TEST, OR THE LOAD TESTS.

Input Voltage Level.

- Check and record regulator input voltage (across terminals X1 and X2) and input current
- If the voltage is not correct (within + 5 percent of design voltage), notify the electrical supervisor.

Output Amperage.

- Using clamp-on ammeter, check and record the output current (from H1 or H2) into the circuit loop on each brightness step.
- Compare results with the tolerances listed in Table 2.
- Consult the manufacturer's instruction book for information on adjusting output current.

Table 2, Regulator Tolerances

TYPE	STANDARD	TOLERANCE
20 Ampere, 5 step	20.0 A	19.50-20.50
20 Ampere, 4 step	15.8A	15.41-16.20
20 Ampere, 3 step	12.4A	12.09-12.71
20 Ampere, 2 step	10.3A	10.04-10.56
20 Ampere, 1 step	8.5 A	8.29-8.71
6.6 ampere, 5 step	6.6 A	6.47-6.70
6.6 ampere, 4 step	5.2 A	5.07-5.33
6.6 ampere, 3 step	4.1 A	4.00-4.20
6.6 ampere, 2 step	3.4 A	3.22-3.49
6.6 ampere, 1 step	2.8 A	2.73-2.87
6.6 ampere, 3 step	6.6 A	6.40-6.80
6.6 ampere, 2 step	5.5 A	5.34-5.67
6.6 ampere, 1 step	4.8 A	4.66-4.97

Percent Loaded.

- Check the load on the regulator by multiplying the input voltage times the input current times the regulator power factor (P = E x I x .95pf).
- To operate effectively and without damage, an airfield constant current regulator must be loaded to at least 50% and no more than 100% of its kw rating.
- Ideally it will be loaded to 80% of its kw rating. Make sure that the load value does not exceed the given kw rating of the regulator.

Short Circuit Test.

- **Turn off power to the regulator.**
  - Remove fused cut-outs if present.
- **Short the output terminals (jumper wire).**
  - Using #10 AWG wire (or larger) across the terminals.
- **Turn on the regulator.**
  - Install the fused cut-outs
  - Advance intensity through each step

Read the output current on each step.

- The output current should be within the tolerances for the type of regulator specified.

Turn off regulator.

Disconnect the (jumper wire) short and reconnect the output cables.

Compare the short-circuit values with those obtained from the monthly output current readings.

- If the values differ by more than the tolerances in Table 2, there is a problem with the field loop or the regulator.

Open-Circuit Test.

SAFETY:
PERFORM THIS TEST ONLY ON THOSE REGULATORS WITH OPEN CIRCUIT PROTECTIVE DEVICES.

Step 1: Turn off the power to the regulator.

Step 2: Disconnect cables from the output terminals.

Step 3: Turn on the power to the regulator.

Step 4: Advance the brightness selector switch to any step.

- The open-circuit protective device should automatically operate within two seconds to turn off the regulator.

Step 5: Turn off the selector switch.

- The open-circuit device should reset.

Step 6: Turn the selector switch to any step.

- The regulator should turn on, then off again within two seconds.

Step 7: If the test is satisfactory, turn off regulator power and reconnect output cables.

Procedures to isolate regulator are as follows:

Step 1: Notify control tower.
- Let them know the amount of down-time is going to be required

Step 2: De-energize the regulator.
- Low voltage regulators are de-energized with a circuit breaker and high voltage regulators are de-energized with a fused cutout.

Step 3: Check for voltage at regulator.
- Use appropriate meter and check across X1 and X2.

Step 4: Block and tag.
- Tag with red tag--AF Form 979

Step 5: Disconnect X1 and X2.
- Input cables

SAFETY:
SOME AIRFIELD LIGHTING SYSTEMS MAY USE SHIELDED AIRFIELD CABLE DEPENDING ON THE TYPE OF REGULATOR (USUALLY THE MORE ADVANCED SYSTEMS WHICH UTILIZES A CABLE DIAGNOSTIC AND FAULT LOCATING CAPABILITIES). THIS TYPE OF CABLE MAY POSE A HAZARD IF OTHER AIRFIELD CABLES IN THE SAME DUCT ARE ENERGIZED WHILE PERFORMING MAINTENANCE ON THE REGULATOR INSURE THAT THE SHIELD IS PROPERLY GROUNDED. LOCAL OPERATING INSTRUCTIONS AND/OR MANUALS SHOULD BE IN PLACE AND STEP BY STEP INSTRUCTIONS ON HOW TO ISOLATE CABLES TO FOR MAINTENANCE AND TESTING

SAFETY:
DUE TO THE HAZARD OF TRANSIENT VOLTAGES (E.G. LIGHTENING, INDUCED VOLTAGES, DETERIORATING CABLE AND SHORTED CABLES IN DUCT SYSTEMS) THERE IS A POSSIBILITY BACKFEED OF VOLTAGE/CURRENT ON TO THE CABLES THAT ATTACH TO THE H1 AND H2 TERMINALS. ALWAYS WEAR YOUR PROTECTIVE EQUIPMENT AND TREAT ALL AIRFIELD CABLES AS IF THEY ARE ENERGIZED. JUST BECAUSE YOU HAVE YOUR REGULATOR DE-ENERGIZED THERE IS ALWAYS THE POSSIBILITY OF BACKFEED THAT COULD CAUSE DEATH OR INJURY AND DAMAGE TO EQUIPMENT.

Step 6: Ground terminals.
- H1 and H2

Step 7: De-energize control circuits.
- Turn off at breaker and check for voltage at the regulator.

Step 8: The regulator is now safe to work on.

During the visual inspection, you will check for:

- Tracking on the bushings, burn marks, cracks, chips, dirt, and grease.
- Check connections for tightness, corrosion, or arcing.
- Make sure that all switches work properly, have tight connections, and are not burned or discolored.
- Inspect relays for burned or pitted contacts, burned or melted wires and tight connections.
- Check fuses to ensure they are correct size and are not blown or burned.
- Check all exposed wiring for evidence of discolored, burned, or melted insulation.
- Inspect tank for leaks, rust, and corrosion.

Procedures for a di-electric test are as follows.

- Take at least a 1-pint sample of oil through the oil sampling valve at the base of the regulator tank
- Check oil for proper level, contamination and check dielectric strengths (Mineral oil is tested at 22 KV).
- If the oil is dirty or the di-electric strength is low, replace or filter it and allow to dry to restore its di-electric strength.
- Wash out sludge deposits on the core and coil assembly and in the tank.
- Clean with dry air.
- Fill with oil to the proper level.

Unscheduled Checks. Clean rust spots on the equipment and repaint as necessary.

Review Questions
for
Constant Current Regulator

Question	Answer
1. What must be accomplished before any maintenance is done on the regulators?	a. Notify tower b. Perform function checks c. Nothing needs to be done d. Turn off power to the airfield vault
2. Control power for both high and low voltage regulators comes from _____.	a. The regulator itself b. A generator c. A fuse and relay d. Solely from the tower
3. What is used to clean a relay with silver contacts?	a. Use a fine file b. 80 grit sand paper c. Use the edge of a knife blade d. Use either crocus cloth or burnishing tool
4. What is the minimum size wire that can be used to jumper the output terminals when performing a short-circuit test?	a. #4 AWG b. #6 AWG c. #8 AWG d. #10 AWG
5. At what voltage is the mineral oil tested?	a. 110 volts b. 2200 volts c. 22KV d. Only at the operating voltage
6. On regulators with an open-circuit protection device how long does the open have to be present before it should operate?	a. 2 minutes b. Instantaneously c. 2 seconds d. 20 seconds
7. When isolating the regulator, and you have blocked, tagged and removed the X1 and X2 cables, what should you do next?	a. Notify tower b. Perform an open-circuit test c. Ground the output terminals d. Remove the primary cut-out fuse
8. What should you do when you notice that the input voltage present on the X1 and X2 terminals is lower than the previous months reading?	a. Increase the taps on the transformer that supplies voltage b. Increase the voltage output at the substation c. Notify the electrical supervisor d. Do nothing
9. When disconnecting the H1 and H2 you should _____?	a. Block and tag the input b. Wear you rubber gloves c. Have another qualified person with you d. Both “a” and “b” e. All of the above

CONSTANT CURRENT REGULATORS

Performance Checklist			
Step		**Yes**	**No**
1. Did the trainee coordinate with tower?			
2. Did the trainee properly isolate the regulator to include blocking and tagging?			
3. Did the trainee accomplish all inspections?			
a)	Oil level check		
b)	Input- output connections		
c)	Relay panel connections		
d)	Protective relays		
e)	External inspections		
4. Does the trainee know how to perform regulator tests?			
a)	Short circuit test		
b)	Open circuit test		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

MAINTAIN AIRFIELD LIGHTING SYSTEMS

MODULE 19 **AFQTP UNIT 4**

CONTROL COMPONENTS (19.4.2.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

CONTROL COMPONENTS

Task Training Guide

STS Reference Number/Title:	19.4.2. – Airfield lighting systems, maintain airfield lighting systems control components
Training References:	• AFI 32-1064, Visual Air Navigation Systems • AFP 91-28 • TO's 35F5-3-12-1, 35F5-4-2-1 • CDC 3E0X1B Vol. 3
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Multimeter • Burnishing tool • Crocus cloth • Hand tools • Protective equipment
Learning Objective:	• Given equipment, maintain airfield lighting systems control components
Samples of Behavior:	• Follow approved procedures to maintain airfield lighting systems control components • Know safety requirements associated with maintaining airfield lighting systems control components
Notes:	
• Any safety violation is an automatic failure.	

CONTROL COMPONENTS

Background: The majority of repairs on control equipment can be prevented by a suitable schedule for maintenance and good housekeeping practice. The operation of all controls should be checked daily. Keeping apparatus clean and in good repair will minimize the maintenance requirements; however, due to wear and failure of equipment, some apparatus will require replacement regardless of the care received. In general, a well-planned schedule of inspections and maintenance will pay large dividends in few interruptions and long life of the equipment. More frequent inspections may be necessary for apparatus that receives hard service or is located in dirty, dusty, or damp locations. Only specially trained personnel should attempt to service and maintain control equipment.

The components of the control circuit that you will need to maintain are: wires, connections, contacts, switches, and relays.

Wires. Complete wiring diagrams are useful when servicing control components. The diagrams should be up to date and should include any changes made after installation. Wires in general require very little maintenance although it is possible for a wire to cause electrical problems.

Connections. Connections should also require little maintenance. Periodically, and after any wiring changes, the circuits should be completely checked for proper operation. Maintaining connections free and clear of dirt, dust, grease, and other contaminants will help ensure proper operation. Loose connections may occur at times and should be corrected as soon as possible to avoid serious damage to other equipment.

Contacts. Contacts are probably one of the most problem causing components in the system. Due to the fact that they are constantly opening and closing under energized conditions a lot of arcing takes place. This arcing causes the contact surface to become burned and pitted. They should be cleaned at least annually if not required more often.

Switches. All switches will be checked for proper operation. This will include checking for loose connections, burned, or pitted contacts and burned or melted wires.

Relays. Relays and coils should be inspected periodically for dirt, heating, freedom of moving parts, corrosion, wear, and noise. Spare parts should be kept on hand particularly if the equipment cannot be taken out of service for long periods of time.

To perform the task, follow these steps:

Step 1: Coordinate control of components with tower.

- Before any work can be done on control components, the control tower must be notified and control taken in the vault.

Step 2: Isolate the circuit.

- The second step will be to isolate the circuit.
- To do this, you must de-energize the control components, take voltage readings, and block and tag the breakers so that no one will be able to accidentally turn them on.
- After these procedures are done, it should be safe for you to inspect and maintain the components.

Step 3: Inspect and clean.

- Part of the preventive maintenance procedure is to inspect and clean the wires, connections, contacts, switches, and relays.
- The inspection is done to look for potential trouble spots before they go bad.
- Look for discolored or melted insulation on the wires.
- Check for a loose connection at one of the terminal boards or other places of connection.
- Another frequent cause of problems is burned, pitted, or dirty contacts in the switches or relays.
- Ensure that the connections to the switches and relays are tight and not discolored either.

NOTE:
When troubleshooting circuits, always begin at the control power source, usually at the circuit breaker panel. Troubleshooting airfield control circuits is normally performed on energized "live" circuits; therefore, a voltmeter is a troubleshooter's best friend. If, at any stage during your troubleshooting procedure, you discover that a piece of equipment or component in the circuit is faulty; you will repair it if possible or replace the component.

Step 4: Correct discrepancies.

- If the wires are discolored or have melted insulation, it will be necessary to replace them.
- Be sure to replace them with wires of equal ampere carrying capacity.
- Connections should be tightened as soon as it is discovered they are loose.
- If they have become dirty or arcing has occurred, clean them up.
- The most common materials used for control equipment power contacts are silver, copper, weld resistant alloys, and sensitive materials.
- Silver tips should never be filed and cleaning with abrasive materials should be discouraged.
- A fine burnishing tool or crocus cloth is best for cleaning these contacts.
- Copper and weld resistant tips may be filed; however, care must be taken to ensure that only the necessary amount of oxide is removed to attain good contact.
- The so-called sensitive materials including gold, platinum, and rhodium are used for special applications where good electrical connection with low contact pressure is desired.

NOTE:
The manufacturer's instructions should be followed for treating these contacts.

- For contacts that are operated frequently and are required to switch large currents, frequent inspections and cleaning may be necessary.
- Normally switches and relays that need repair are not repaired but rather replaced.
- It is more economical to replace them than to expend the time trying to repair them due to their low cost and the difficulty of working on them.

Step 5: Return tower control.

- When all the necessary maintenance has been performed the procedures to take control of the airfield will be reversed and the controls will be checked for proper operation.

- The last thing done will be to notify the control tower that the control of airfield lights has been returned to them.

NOTE:
Maintenance is performed on airfield equipment to ensure dependable and safe operation. The procedures that we have given you are a minimum that must be done when maintaining airfield equipment.

SAFETY:
ANYTIME ANY WORK IS PERFORMED ON ELECTRICAL CIRCUITS, WHETHER ENERGIZED OR NOT, ALL JEWELRY MUST BE REMOVED. METAL FRAMED GLASSES SHOULD NOT BE WORN SINCE THEY COULD POSSIBLY FALL INTO AN ENERGIZED CIRCUIT. IF SOLDERING IS GOING TO BE ACCOMPLISHED, BE SURE TO WEAR A SET OF PROTECTIVE GOGGLES. YOU ONLY HAVE ONE SET OF EYES.

Review Questions for Control Components

Question	Answer
1. Before any work can be done on control components, the _____ must be notified and control taken in the vault.	a. NCOIC b. Shop foreman c. Tower d. All of the above
2. A fine _____ is best for cleaning silver contacts.	a. Crocus cloth b. Burnishing tool c. Gerber d. Tooth comb
3. Any time any work is performed on electrical circuits, whether energized or not, all _____ must be removed.	a. Connections b. Grounds c. Control Circuits d. Jewelry
4. Contact should be cleaned at least _____?	a. Daily b. Monthly c. Semi-annually d. Annually
5. When troubleshooting circuits, ALWAYS begins at the control power source, usually at the circuit breaker panel.	a. True b. False

CONTROL COMPONENTS

Performance Checklist			
Step		**Yes**	**No**
1. Did the trainee use the required equipment needed to maintain control components?			
a.	Multimeter		
b.	Hand tools		
c.	Burnishing tool		
d.	Crocus cloth		
2. Did the trainee know the process for maintaining control components?			
3. Did the trainee recognize the safety factors surrounding maintaining control components?			

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

MAINTAIN AIRFIELD LIGHTING SYSTEMS

MODULE 19 AFQTP UNIT 4

FIXTURES (19.4.4.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

FIXTURES

Task Training Guide

STS/ Reference Number/Title:	9.4.4. – Airfield lighting systems, maintain airfield lighting systems fixtures
Training References:	• AFR 88-14 (AFI 32-1044), Visual Air Navigation Systems • TO 35F5-3-12-1 • TO 35F5-4-2-1 • AFMAN 32-1064, Electrical Safe Practices • CDC 3E051, Vol. 3B
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Personal Protective Equipment • Hand Tools
Learning Objective:	• Given equipment, maintain airfield lighting fixtures
Samples of Behavior:	• Follow approved procedures while maintaining airfield lighting fixtures • Know safety requirements associated with working on airfield lighting fixtures
Notes:	
• To successfully complete this element, the trainee must be able to identify proper procedures for working on airfield lighting fixtures without violating any safe practices. • Any violation of safe practices constitutes failure.	

FIXTURES

Background: Airfield lighting provides the pilot of an aircraft with visual aids while on the ground, while taking off, and while landing at night or during inclement weather. There are many different lighting systems on the airfield. Some of these systems are taxiway lights, runway edge marker lights, approach lights, and threshold lights. Airfield lighting systems are essential in the safe movement of aircraft, and must be kept in top condition at all times. Airfield lighting fixtures are exposed to all of the seasonal elements--from freezing rain and snow in the winter, to blistering heat and direct sunlight during the summer. These elements directly effect the lighting fixture. In addition to the weather, several other factors to be considered are: breakage due to aircraft, snow plows, and vehicles, even animals that chew on the insulation around the conductor supplying power to the fixture. All of these can be contributing factors to poor quality lighting if maintenance is not being done properly, and on a continual basis.

Maintenance requirements.

- Although base operations performs a daily check of the airfield lighting system, you are still responsible for the maintenance and operation of the system. You must constantly check the lighting system for conditions that could cause the system to fail. A regular maintenance program is essential for maintaining the airfield lighting.

NOTE:
The following is a basic layout for a maintenance program. Procedures may differ from base to base due to specific conditions or differences at that base.

Weekly checks.

- Perform a visual inspection of the systems. This should consist of driving patrol to check for dimly burning bulbs, for burned-out lamps, and for fixtures out of alignment. Make corrections as soon as possible. Replace dimly burning bulbs and burned out lamps when the system is deactivated. If this is not possible, and the system is energized, use rubber gloves and protectors. Be sure that the lamp is intact. Daily checks may be necessary at bases where the control tower does not report outages, or where there is constant harsh weather.
- Replace broken lenses with proper type and color. Clean lenses as required.
- Check for any debris that can obstruct the pilot's view of the light, and be sure the debris is cleared from the light fixture.

Monthly checks.

- Check the orientation of all lenses. Make this check by viewing the lights at night. Improper alignment makes the light units appear dimmer or brighter than those that are properly aligned.
- Straighten, level, and align all lighting fixtures that have been knocked out of alignment.

- Check lamps, and sockets for cleanliness and proper electrical connections. If moisture is present, replace the fixture gasket.

Semi-Annual checks.

- Check the ground elevation around the lighting fixture.
- Check light bases and housings for evidence of moisture penetration. Check gaskets, seals, and clamps for deterioration and damage. Check the torque of the light base cover bolts.
- Check fixtures, bases and housing for corrosion, rust and peeling paint.

Annual Checks.

- Carefully check each light fixture for cracking, corrosion, or shorts.
- Clean contacts and make sure the lamp fits firmly into the receptacle.
- Check the condition of all connections.
- Check the runway cable insulation resistance (meg-ohm) check.
- Check all gaskets on fixtures with evidence of moisture, and replace with new rubber gaskets.

To perform the task, follow these steps:

Step 1: Coordinate Airfield Control with the Tower.

- Any time that you are going to be working on a fixture, you should take control of the airfield lighting. This prevents someone in the tower from energizing the circuit while you are working on it.

Step 2: Isolate Circuit.

SAFETY:
TO FURTHER PREVENT AN ACCIDENTAL ENERGIZING OF THE CIRCUIT WHILE YOU ARE OUT ON THE AIRFIELD AND AWAY FROM THE VAULT, ISOLATE THE CIRCUIT.

- Pull the primary fuse or open the circuit breaker supplying power to the regulator.
- De-energize the control power to the regulator
- Disconnect the circuit from the regulator

NOTE:
This is normally accomplished by unplugging the joy connectors and plugging the ones still connected to the regulator together. This prevents the secondary side from being open should the regulator become energized and plugging the joy plugs on the circuit ends together.

Step 3: Disassemble Fixture (Elevated).

- Remove it from the break-away coupling by unscrewing the set screws on the base of the fixture
- Pull the cord attached to the fixture away from the breakaway coupling to unplug the fixture from the IL transformer.
- Remove the lens by taking off the retaining ring or clips.
- Remove the electrical portion of the fixture that is held on by screws.

- The fixture is now torn apart as far as needed to repair or replace any broken parts.

Step 4: Repair or Replace Unserviceable Parts (Elevated).

- The damage to an elevated fixture could be as simple as a broken lens.
- The damage could be much more extensive and require you to remove the fixture, salvage as much as you can from the fixture, and rebuild it almost from scratch.
- Once the fixture has been rebuilt, place it back into service.

Step 5: Disassemble Fixture (Semi-Flush).

NOTE:
Damage to a semi-flush fixture normally requires that more extensive work be accomplished because it takes more to damage one. If the lid is damaged, it needs to be replaced since there is not much you can do to fix one.

- Remove the lid, which is the cover for the canister.
- Depending on the type of fixture, the lens, and lamp may be internal, or external.
- Unplug the joy plug from the secondary side of the Isolation Transformer.
- Once the fixture is isolated from the circuit you can disassemble the lid and make needed repairs.

Step 6: Repair or Replace Unserviceable Parts (Semi-Flush).

- The bulb-holder legs and the plug can be easily replaced but the entire fixture needs to be removed from the ground in order to get at the parts.
- If enough force is applied to the fixture to damage it, it is usually ripped from the ground.
- This severs the bolts in the rings.
- These bolts can be removed from the rings, the rings salvaged, and used again, but it requires more work to accomplish these repairs.

NOTE:
Fixtures come in various styles, and depending on the type of fixture you are working on the repairs may vary. Check the manufacturer specifications before attempting any repairs.

Step 7: Adjust Fixture.

- Because of ground settling, fixture repairs, and new fixture installation, fixtures must be aligned to ensure maximum efficiency of the light, and that the light projected will not glare in the pilot's eyes.
- The type of light and where it is used will dictate if the light is set level or if it will be tilted.

Review Questions
for
Fixtures

Question	Answer
1. When working on the airfield lighting system, you should always coordinate with the control tower.	a. True b. False
2. Elements that have an adverse effect on airfield fixtures are _____.	a. Snow, and ice b. Vehicles c. Animals d. Blistering heat, and sunlight e. All of the above
3. There are many different systems of lights used on the airfield.	a. True b. False
4. Constantly check the lighting system for conditions which could cause the system to fail.	a. True b. False
5. The runway cable insulation resistance (meg-ohm) check should be done_____.	a. Weekly b. Monthly c. Semi-annually d. Annually
6. Because of ground settling, fixture repairs, and new fixture installation, fixtures must be aligned to ensure maximum efficiency.	a. True b. False

FIXTURES

Performance Checklist		
Step	**Yes**	**No**
1. Did trainee notify control tower to get access on to runway?		
2. Did trainee follow the proper procedures for isolating the airfield circuit?		
3. Does trainee know the proper procedures for repairing elevated lighting fixtures?		
4. Does trainee know the proper procedures for repairing semi-flush lighting fixtures?		
5. Did trainee properly adjust fixtures?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

MAINTAIN AIRFIELD LIGHTING SYSTEMS

MODULE 19 AFQTP UNIT 4

APPROACH PATH INDICATORS (19.4.9.)

APPROACH PATH INDICATORS

Task Training Guide

STS Reference Number/Title:	19.4.9. – Airfield lighting systems, maintain airfield lighting systems approach path indicators
Training References:	• AFI 32-1044, Visual Air Navigation System • AFP 91-28 • CDC 3E051B Vol. 3
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Electrical hand tools • Rubber protective equipment • Electrical meters
Learning Objective:	• Given equipment, maintain approach path indicator systems • Trainee needs to be able to identify the different types of Approach Path Indicator systems, and maintenance required
Samples of Behavior:	• Follow approved methods to maintain approach path indicator systems • Identify different approach path indicator systems • Know safety requirements for maintaining approach path indicator systems
Notes:	
• To successfully complete this element trainee must be able to identify the maintenance required for each Approach Path Indicator system.	

APPROACH PATH INDICATORS

Background: Maintenance is the key to keeping the Approach Path Indicator (API) systems operating properly. We will cover three types of API systems: Visual approach slope indicator (VASI), Precision approach path indicator (PAPI), and the Pulse light approach slope indicator (PLASI), and the maintenance required for each.

To perform these tasks, follow these steps:

Step 1: Visual approach slope indicator (VASI) system daily checks.

- Check that all lamps are burning and are of equal brightness.
- Have adequate spare lamps available to permit complete replacement of all lamps in the system.
- Stock spare bypass (grasshopper) fuses, if the system uses them.
- Immediately replace lamps if they burn out or become darkened.
- If the VASI uses bypass fuses, check the associated fuse before you replace a lamp.

Step 2: (VASI) Monthly checks.

- Check operation of controls. Check photocell brightness control and runway light circuit interlock (if used), radio control (if used), and remote control switch.
- Check for damage from mowers or snowplows.
- Clean lamps and filters.
- Visually check mechanical parts for cleanliness, burned wires, or connections, cracked insulators, lamps, or filters.
- Check if lightning arresters or surge suppressers show other signs of being burned out and replace as necessary. Also, check after electrical storms.
- Check for damage or debris from water, mice, ants, wasps, bird nests, spider webs, and so forth, in lamp boxes and adapter units; clean or repair as needed.
- Check for burrows or other signs of rodent activity in the vicinity of cables. Take steps to discourage their presence and thus reduce the chances of cable damage.
- If you use an adapter unit, read and record the output current and the input voltage to the adapter unit.
- Check the horizontal and lateral alignment of the light boxes and check the aiming (vertical angle) with the VASI aiming bar. Coordinate the correct horizontal and lateral alignment with airfield management. Record the date and angle setting. Check the aiming frequently when the soil freezes or thaws or has a change in moisture content (especially clay soils).
- Check leveling and operation of the tilt switch (used in VASI–2 and some VASI–4 installations.

Step 3: (VASI) Semiannual checks

- Check insulation resistance of underground cables and record the results.

Step 4: (VASI) Biennial checks.

- Perform a ground resistance measurement of ground rods every 2 years using a vibroground test meter. If the resistance is greater than 25 ohms, lower the resistance.

Step 5: Adjusting the vertical aiming.

- This we normally do with an aiming bar, a calibration bar, and a small (machinist's) level. Carefully handle these precision instruments. Make sure the aiming bar is the one that comes with the VASI light units. Perform the following steps when you check the VASI.
- Place the calibration bar on a rigid surface that is approximately level, such as a concrete floor or a table or counter that is sitting on a concrete floor. Most wooden floors deflect enough under one person's weight to make it impossible to accurately level the calibration bar.
- Place the small level on the calibration bar and level it with the adjustable feet, both in the linear and transverse directions.
- Turn the small level 180° to check for centering of the bubble. If the level does not check when you reverse it, adjust the small level so that the bubble remains centered when you reverse the small level.
- Place the aiming bar on the calibration bar and check that its spirit level remains centered in the 0°, 3°, and 6° positions and settings. Adjust the spirit level if necessary to center the bubble. If you can not center the bubble at each of the three angles, replace the aiming bar.
- Place the instruments in the carrying case for transporting out to the VASI boxes.
- Place the small level on the bottom center of the aperture (light slot) at the front of the box and level the box transversely with the two front adjusting (mounting) screws.
- Set the proper angle on the aiming bar (usually 2 1/2° for light bar No. 1, which is closest to the runway end, and 3° for light bar No. 2) and insert it through the aperture so the end of the aiming bar resets on the transition bar.
- With the aiming bar in line with the left-hand lamp, adjust the left rear adjusting screw. Move the aiming bar to the right side of box and adjust the right rear screw. Repeat for left and right side until bubble is centered at each position.
- Recheck transverse leveling and recheck longitudinal leveling with the aiming bar in the center of the light box.
- Stand in front of the VASI box (approximately 50 feet away) and check that the light changes color simultaneously along with the whole width of the unit. If not, either you did not do the leveling properly, the box is warped, or the transition bar is not in its proper place.
- Check the tilt switch on all VASI–2 systems and VASI–4 systems (where provided) by placing the small level on the marked top surface of the tilt switch and adjusting the tilt switch if necessary. If the tilt switch shuts off the power when it is level, replace the tilt switch. Turn the main switch off and on to reset tilt switch circuit.

Step 6: Checking adapter unit current output.

- With system on, adjust day current to 6.4 to 6.6 amperes.
- Cover photocell with heavy glove or other dark material, wait for time delay to de-energize, and read current. If the VASI has a night adjustment, set current to 4.8 to 5.0 amperes.
- Remove covering from photocell. The lights should switch back to day brightness after short-time delay (15 seconds to 1 minute).

Precision Approach Path Indicator System (PAPI).

- A PAPI system consists of four identical light units (FAA Type L–880).
- Normally, these light units are positioned to the left side of the runway and provide the aircraft pilot approaching the runway with the correct glide slope.
- When the plane is on a correct glide slope, the pilot sees two red and two white lights in a bar.
- If the aircraft is below the glide slope, the pilot sees a progressively increasing number of red lights.
- Conversely, if the aircraft goes above the glide slope, the pilot sees the number of white lights increase.
- A PAPI unit contains two or three projector modules.
- When viewed from a distance, the projected light beams appear as a short horizontal bar.
- Each projector contains a lamp, reflector, color filter, baffle, and lens.
- The edge of the color filter is precision ground. It provides a very sharp transition between the red and white portions of the beam.
- If it becomes necessary to change the filter or lens, refocus the filter.
- Each light unit contains a tilt switch mechanism.
- This mechanism is factory adjusted to open the circuit if the light unit becomes misaligned more than 1/2° down or 1° up.

Step 1: PAPI daily checks.

- Inspect for burned-out-bulbs and replace if necessary.

Step 2: PAPI weekly checks.

- Clean and inspect lens, filters and reflectors.

Step 3: PAPI monthly checks.

- Verify light unit elevations
- Check tilt switch system by pulling on tilt switch cord. System should not stay on for more than 30 seconds.
- Verify tilt switch mechanism alignment.

Step 4: PAPI semiannual checks.

- Verify complete base casting alignment
- Check power and control unit for loose connections, broken or missing parts.
- Operate unit in brightness steps; first by local control; then by remote control (if used).
- Remove dust buildup from power supply and unit.

Pulse Light Approach Slope Indicator (PLASI).

- A PLASI system, when properly installed and oriented, furnishes the pilot with precise visual approach slope information for safe descent guidance to an airfield.
- The PLASI provides this visual vertical glide path information by projecting a beam of light along the desired descent path to the touchdown point.
- PLASI is a ground installed, self-contained device that is housed in a single box.
- From the pilot's view, the device generates and projects four horizontal bands of light, only one of which can the pilot see at a given instant.
- The center light band is a steady white light projected at a 0.35°-high angular wedge (plus or minus 0.02), 16° wide, with the apex at the PLASI.
- This center band defines the correct glide path.
- The upper band of white light pulsing at 2.2 pulses per second is a wedge approximately 2.5° high by 16° wide, which gives "above glide path" indication.
- A similar lower band of pulsing red light provides the "below glide path" information.
- In between the steady white, on-glide-path signal and pulsing red, below-glide-path signal is a solid red sector of 0.175° height by 16° width which is the slightly below glide path signal.
- This signal advises the pilot that the aircraft is at 2.65° (for 3° approach) at the lower edge of the steady red.
- The pulses of the white "above" and red "below" lights vary in length from continuous, at the edge of the glide path, to zero length at the "off glide path" limit of visual contact.
- This variation in light-pulse length (long, near the path, and becoming shorter and shorter as deviation from glide path increases) gives the pilot quantitative information on deviation.
- Rate of change of pulse length provides rate of deviation from or closure with the glide path.
- The visual presentation is accomplished through the use of optical components, a movable shutter, and a red filter.
- One tungsten-halogen lamp is positioned behind a condenser lens.
- For reliability, an automatic lamp changer inserts a new lamp within 1 to 4 seconds if the one in use should fail.

NOTE:
There are two checks that are needed with the PLASI system semiannual checks and unscheduled checks.

Step 1: PLASI semiannual checks

SAFETY:
ALWAYS TURN THE POWER OFF BEFORE YOU OPEN THE HOUSING.

- Open and securely latch the housing top. Make sure the external level beam index mark is set to the desired approach scale on the degree scale and that the bubble in the beam level is centered. Adjust if necessary.
- Inspect the air inlet filter to the dual fan motor. If the filter is corroded or damaged, replace with a new filter. If filter is dirty, remove and clean with a water and detergent solution. Rinse thoroughly, air dry, and replace.
- Check the drive chain for proper tension. With the power on and the chain running, it should be possible to deflect the top strand of the chain approximately 3/8 inch. Adjust if necessary after you turn the power back off. Lubricate the chain sparingly with SAE 50-weight non-detergent oil. Check the tightness of all sprocket set screws (6 locations).
- Check the upper and lower shutter chains for correct tension. With the power on and chains running, the chain sag should be approximately one-eighth of an inch. Turn the power off and adjust the chain if necessary. Check tightness on all six sprocket set screws. Lubricate the chains and sprocket teeth sparingly with SAE 50-weight non-detergent motor oil. Do not contaminate the red filter or condenser lens with oil.
- Remove oil plug on the shutter motor and check oil level in the gear case. Add SAE 50-weight non-detergent oil as required.
- Check for correct photocell operation. With the system operating on daytime lamp voltage, cover the photocell. Within 3 minutes, the photocell should reduce lamp voltage to the night setting (approximately 30 to 40 volts). Uncover the photocell and, within 3 minutes, full voltage should return to the lamps.

Step 2: PLASI unscheduled checks.

- Replace failed lamp when the illumination of the red indicator lamp indicates such action is necessary.
- Move the lamp in service to the No. 1 socket and install new lamps in all other sockets.

NOTE:
Do not touch lamps with You bare fingers as body chemicals cause the lamp to become opaque. Use a clean cloth or gloves when you handle lamps. If you touch lamp surfaces with your bare hand, clean those surfaces with alcohol.

- Reset the lamp table so that the number 1 lamp is in the service position and turn on the power. Trigger the lamp table through all positions.
- Check for proper operation of all the lamps.
- Check that the table seats in the detent roller at each position.
- External red lamp should be illuminated when lamp No. 5 is operating. Turn off the power and reset the lamp table to the No. 1 position.
- When you replace a lamp, clean the inside and outside of the front window, condenser lens, the objective lens, and red filter, with a high quality lens cleaning fluid.
- Replace any damaged optical component.

Review Questions
for
Approach Path Indicators

Question	Answer
1. The key to keeping approach path indicators operating properly is regular _____.	a. Maintenance b. Service c. Cleaning d. None of the above
2. VASI lamps and filters need to be cleaned _____.	a. Daily b. Weekly c. Monthly d. Annually
3. Check the leveling and operation of the VASI tilt switch_____.	a. Daily b. Weekly c. Monthly d. Annually
4. Check insulation resistance of VASI underground cables and record the results_____.	a. Daily b. Weekly c. Monthly d. Semi-annually
5. A PAPI system consists of _____ identical light units (FAA Type L-880).	a. 2 b. 4 c. 6 d. 8
6. Normally PAPI light units are placed on the left side of the runway and provide the aircraft pilot approaching the runway with the correct glide slope.	a. True b. False
7. A PAPI unit contains two or three projector modules.	a. True b. False
8. Inspect PAPI units for burned- out bulbs _____.	a. Daily b. Weekly c. Monthly d. Annually
9. PAPI lens, filters, and reflectors need to be cleaned and inspected _____.	a. Daily b. Weekly c. Monthly d. Annually

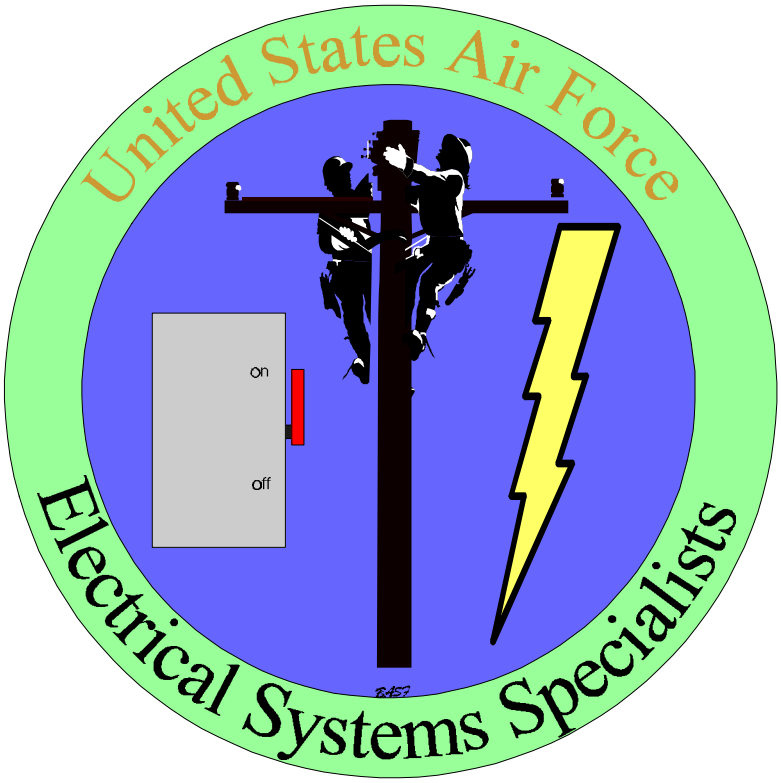
Review Questions
for
Approach Path Indicators

Questions	Answers
10. During monthly checks the tilt switch system needs to be tested by pulling on the tilt switch cord. System should not stay on for more than _____ seconds.	a. 10 b. 20 c. 30 d. 40
11. Remove dust buildup from PAPI power supply and unit semiannually.	a. True b. False
12. PLASI is a ground installed, self contained device that is housed in a single box.	a. True b. False
13. There are two checks that are needed with the PLASI system, they are_____.	a. Daily and weekly b. Semiannual and annual c. Semiannual and unscheduled d. Annual and unscheduled
14. During PLASI semiannual checks you must always turn the power off before you open the housing.	a. True b. False
15. When changing PLASI lamps do not touch the lamps with your bare fingers	a. True b. False

APPROACH PATH INDICATORS

Performance Checklist		
Step	**Yes**	**No**
1. Does trainee understand the importance of API maintenance?		
2. Does trainee know the different types of approach path indicator systems?		
3. Does trainee know the different API maintenance schedules?		
4. Does trainee know the safety requirements for doing maintenance?		
5. Did the trainee know the proper steps to perform maintenance on the different types of systems?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.



AIRFIELD LIGHTING SYSTEMS

MODULE 19 **AFQTP UNIT 5**

ISOLATE AIRFIELD LIGHTING CIRCUITS OR EQUIPMENT FOR TEST (19.5.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

ISOLATE AIRFIELD LIGHTING CIRCUITS OR EQUIPMENT FOR TEST

Task Training Guide

STS/ Reference Number/Title:	19.5. – Airfield lighting systems, isolate airfield lighting circuits or equipment for test
Training References:	• AFR 88-14 (AFI 32-1044), Visual Air Navigation Systems • T.O. 33A1-3-102-1, Test Set, Airfield Lighting Systems • AFMAN 32-1064, Electrical Safe Practices • CDC 3E051, Vol. 3B
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Personal Protective Equipment • Grounding Set • Hotline Tools • Hand Tools • Voltage meter • Clamp-on amp meter
Learning Objective:	• Given equipment, isolate airfield lighting systems circuits and equipment for testing
Samples of Behavior:	• Follow approved procedures, isolate airfield lighting systems circuits and equipment for testing • Know safety requirements associated with isolating airfield lighting systems circuits and equipment
Notes:	
• To successfully complete this element, the trainee must be able to identify proper procedures to isolate airfield lighting systems circuits and equipment without violating any safe practices. • Any violation of safe practices constitutes failure.	

ISOLATE AIRFIELD LIGHTING CIRCUITS OR EQUIPMENT FOR TEST

Background: Whenever an electrical circuit or piece of equipment needs to be tested, repaired, or replaced it is necessary to render it safe. To ensure the circuit or piece of equipment is de-energized, procedures must be followed precisely to prevent damage or bodily injury through electrical shock.

To perform this task, follow these steps.

Step 1: Coordinate control of airfield.

- Contact the control tower and ask permission to take control of the airfield lighting. This is necessary to ensure that no aircraft are going to land or take off with the aid of the lights. The tower should be advised as to how long you will need control.

NOTE:
If extended down time is required for maintenance, it may need to be rescheduled to accommodate the longer down time.

Step 2: Determine circuit to be worked on.

- Identify the circuit requiring maintenance. Once the circuit is chosen, you need to locate the electrical inputs for that circuit.

SAFETY:
KEEP IN MIND THAT EVERY REGULATOR HAS TWO VOLTAGE INPUTS, A HIGH OR LOW VOLTAGE INPUT AND A LOW VOLTAGE CONTROL CIRCUIT.

Step 3: Disconnect power source.

- Turn the piece of equipment off and remove the input power to it. The input voltage for most equipment is de-energized by pulling the fuse cutout with a hot stick or by turning off the circuit breaker feeding it. Isolate the control circuit to the equipment by turning off the circuit breaker in the disconnect panel feeding the control circuit.

Step 4: Check for power.

- Check the input power source and the control power source for voltage. If isolating a constant current regulator check the output circuit for the presence of current with a clamp-on amp meter.

NOTE:
Test equipment most be tested on a known working circuit prior to using on de-energized circuits, then rechecked on the operation circuit this will ensure that the equipment is properly functioning.

Step 5: Blocking and tagging.

- The two power sources need to be blocked in the open position. After this, they must be tagged with an AF Form 979. Blocking and tagging is for your safety. This will inform all other personnel that maintenance is being performed on that circuit.

SAFETY:
CARE MUST BE TAKEN WHEN ISOLATING AIRFIELD LIGHTING CIRCUITS, BECAUSE OF THE POSSIBILITY OF ONE CIRCUIT BURNING INTO ANOTHER AND THE CLOSE PROXIMITY OF CIRCUITS. ALSO, CARE MUST BE TAKEN TO NEVER PUT TEST EQUIPMENT ON ENERGIZED CIRCUITS. TREAT AN UNKNOWN CIRCUIT AS IF ENERGIZED UNTIL IT CAN BE PROVEN IT IS OTHERWISE.

Step 6: Grounding.

- The input and output bushings should be grounded with appropriate grounding sets.

SAFETY:
GROUNDING SETS ARE USED TO PREVENT OTHER CIRCUITS FROM INDUCING CURRENT ONTO THE CIRCUIT BEING WORKED.

Step 7: Re-energizing.

- When equipment or circuits have been serviced and repaired reverse the step above to bring the airfield back on line.

Review Questions
for
Isolate Airfield Lighting Circuits Or Equipment For Test

Question	Answer
1. Why is it necessary to contact the tower before taking control of the light panel?	a. To see if the lights are on. b. Only as a courtesy. c. To allow pilots time to take off. d. To get permission to take control
2. How many voltage inputs does a constant current regulator have?	a. One b. Two c. Three d. Four
3. To disconnect the power source to the piece of equipment just pull the fuse cut out.	a. True. b. False
4. To check a piece of equipment for power, you must _____.	a. Check test equipment on known source. b. Read input leads to equipment. c. Verify correct operation of test equipment. d. All the above.
5. Why is blocking and tagging important?	a. Keeps the equipment form rolling. b. Clears all faults on the circuit. c. It lets others know that the equipment is being worked on. d. Keeps other circuits from inducing currents onto to circuit being worked on.
6. Why should grounds be used?	a. Clears all faults on the circuit. b. It lets others know that the equipment is being worked on. c. To anchor the equipment. d. Keeps other circuits from inducing currents onto to circuit being worked on.

ISOLATE AIRFIELD LIGHTING CIRCUITS OR EQUIPMENT FOR TEST

Performance Checklist		
Step	**Yes**	**No**
1. Can trainee state the purpose for isolating equipment and circuits?		
2. Did the trainee contact the tower for control of airfield lighting?		
3. Did trainee identify the correct piece of equipment for isolation?		
4. Did trainee correctly identify the power inputs and disconnect them?		
5. Did the trainee check test equipment prior to use to ensure proper operation?		
6. Did trainee use correct meters for checking voltage and amperage?		
7. Did trainee varify proper operation of test equipment?		
8. Were input power circuits properly blocked and tagged?		
9. Can trainee explain the need for grounding?		
10. Were grounding set used properly?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

AIRFIELD LIGHTING SYSTEMS

MODULE 19 **AFQTP UNIT 9**

CONNECT AIRFIELD LIGHTING CONSTANT CURRENT REGULATOR FOR EMERGENCY OPERATION (19.9.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

CONNECT AIRFIELD LIGHTING CONSTANT CURRENT REGULATOR FOR EMERGENCY OPERATION

Task Training Guide

STS/ Reference Number/Title:	19.9. – Airfield lighting systems, connect airfield lighting constant current regulator for emergency operation
Training References:	• AFR 88-14 (AFI 32-1044), Visual Air Navigation Systems • 33A1-3-102-1, Test Set, Airfield Lighting Systems • 35F8 Series, Constant Current Regulators • AFMAN 32-1078, Electrical Safe Practices • CDC 3E051B, Vol. 3
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Personal Protective Equipment • Testing Set • Grounding Set • Hotline Tools • Hand Tools
Learning Objective:	• Given equipment, connect an airfield lighting constant current regulator for emergency operation
Samples of Behavior:	• Follow approved procedures to connect an airfield lighting constant current regulator for emergency operation • Know safety requirements associated with connecting an airfield lighting constant current regulator for emergency operation
Notes:	
• To successfully complete this element, the trainee must be able to identify proper procedures to connect an airfield lighting constant current regulator for emergency operations without violating any safety practices. • Any violation of safety practices constitutes failure.	

CONNECT AIRFIELD LIGHTING CONSTANT CURRENT REGULATOR FOR EMERGENCY OPERATION

Background: Constant current regulators will normally give years of trouble-free service. But, as with all equipment, they do break down. When a regulator does break down, the circuit that it feeds can be connected to another regulator. This is referred to as connecting constant current regulators for emergency operation.

To perform the task, follow these steps:

Step 1: Notify the control tower.

- This is always the first thing done when any work is needed on the airfield.

Step 2: Isolate inoperative regulator.

- Electrically disconnect the regulator from its power source. This means the power supplying the primary side and the control power. Remember there are different types of regulators operating from different voltages. The lower voltage type regulators are supplied with primary power from the circuit breaker panel in the vault. The higher voltage regulators are supplied from a high voltage buss bar in the vault through a primary cutout. The control power for both types of regulators is supplied from the circuit breaker panel through the low burden pilot relays.

Step 3: Disconnect and ground output.

- H1 and H2 bushings on bad regulator

Step 4: Isolate the replacement regulator.

- The output amperage must match that of the inoperative regulator. Perform the same steps as you did with the bad regulator

Step 5: Connect circuits to form one large series circuit.

Step 6: Connect step 5 to step 4.

- Take the control wire off of step 5 relay inside regulator and connect it to the step 4 relay. This is done to ensure regulator will not overload.
-

Step 7: Re-energize and notify tower.

- Take load readings to ensure regulator is not overloaded and check operation.

SAFETY:
RUBBER GLOVES SHOULD BE WORN WHEN CONNECTING REGULATORS. BECAUSE MOST VAULTS HAVE LITTLE WORKING SPACE ANY EQUIPMENT YOU MAY COME IN CONTACT WITH SHOULD BE DE-ENERGIZED BEFORE YOU BEGIN WORKING. THE CONNECTING OF CONSTANT CURRENT REGULATORS FOR EMERGENCY OPERATION IS DONE ONLY WHERE THERE IS NO BACKUP REGULATOR AVAILABLE. IF THE CONNECTION IS NOT DONE PROPERLY, THERE IS A POSSIBILITY OF INJURY TO PERSONNEL, DAMAGE TO THE CIRCUIT, AND DAMAGE TO THE GOOD REGULATOR. BEFORE RE-ENERGIZING THE REGULATOR, CHECK TO MAKE SURE YOUR CIRCUIT IS CONNECTED PROPERLY AND THAT ALL CONNECTIONS ARE TIGHT.

NOTE:
Before re-energizing the regulator, check to make sure your circuit is connected properly and that all connections are tight.

Review Questions
for
Connect Airfield Lighting Constant Current Regulator for Emergency Operation

Questions	Answers
1. To connect a regulator for emergency operation, you should _____ the secondary cables.	a. Parallel b. Series c. Ground d. None of above
2. Connecting step 5 relay to ____relay will keep regulator from overloading.	a. Step 1 b. Step 2 c. Step 3 d. Step 4
3. It is not necessary to notify tower of emergency regulator connections because all airfield lights work.	a. True b. False

CONNECT AIRFIELD LIGHTING CONSTANT CURRENT REGULATOR FOR EMERGENCY OPERATION

Performance Checklist			
Step		**Yes**	**No**
1. Did the trainee identify the proper procedures to connect an airfield lighting constant current regulator for emergency operations?			
a.	Notify the Control Tower		
b.	Isolate Inoperative Regulator		
c.	Disconnect and Ground Output		
d.	Isolate the Replacement Regulator		
e.	Connect Circuits to Form One Large Series Circuit		
f.	Connect step 5 to step 4		
g.	Re-energize and Notify Tower		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

REPLACE

MODULE 19 **AFQTP UNIT 10**

AIRFIELD LIGHT LAMPS (19.10.1.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

AIRFIELD LIGHT LAMPS

Task Training Guide

STS /Reference Number/Title:	19.10.1. – Airfield lighting systems, replace airfield light lamps
Training References:	• AFI 32-1064, Electrical Safe Practices • CDC 34051B, Vol. 3
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Personal Protective Equipment • Flat-tipped screwdriver • Socket Set
Learning Objective:	• Given equipment, replace airfield light lamps.
Samples of Behavior:	• Follow approved methods to replace airfield light lamps. • Know safety requirements associated with isolating Airfield lighting systems circuits and equipment
Notes:	
• To successfully complete this element the trainee must be able to isolate and replace Airfield Light Lamps. • Any violation of safe practices constitutes failure.	

AIRFIELD LIGHT LAMPS

Background: Usually during periodic visual inspections of airfield lighting system's there are discoveries of inoperative light fixtures. The majority of the time problems are related to a burned-out lamp, bad connections, or a bad IL transformer. There are several types of lamps used on airfield lighting circuits. The three that will be discussed here are the pre-focused base, medium bi-post, and PAR lamps.

- The T-20 lamp is the only medium bi-post lamp used on the airfield by the Air Force. It is rated at 500 watts and 20 amps. The T-20 is used in the MB-1 fixture, on runway systems 300' wide and on the winged-out pre-threshold.

- Three different PAR lamps are used on the airfield lighting circuit. They are the PAR-65, PAR-56, and PAR-38. The PAR-65 is rated at 300 watts/6.6 amps. Three PAR-65 lamps are used in each VASI unit.

- There are three different of PAR-56 lamps used. The 500 watt / 20 amp lamp is used in the B-25 fixture in the overrun area of the runway. The 200/300 watt / 6.6 amp PAR-56 lamp is used in the MB-2 fixture on the elevated approach system. The 45 watt / 6.6 amp lamp is used in the B-3 fixture on taxiway circuits.

- The PAR-38 is rated at 45 watts/6.6 amps. Four of these lamps are located in each distance marker.

- Although some of the major steps are the same in changing both elevated and semi-flush fixtures, this guide will discuss each separately to cover the differences between the two.

To perform the task, follow these steps:

SAFETY:
ALTHOUGH IT MAY SEEM LIKE A SIMPLE PROCEDURE FOR REPAIRS, AN IMPROPER PROCEDURE CAN RESULT IN SYSTEM FAILURE OR PERSONAL INJURY. THEREFORE, IT IS VITAL THAT ALL PROCEDURES AND SAFETY PRECAUTIONS BE OBSERVED AT ALL TIMES.

Replacement procedures (semi-flush).

Step 1: Coordinate Control of Airfield.

- The first step in lamp replacement for a semi-flush fixture is to coordinate control of the airfield with the tower. Anytime that you do any work that affects the airfield lights, even just taking control of them, you must clear it through the control tower. Request clearance from the tower to enter the flight line and request their permission to take control of the lighting system.

Step 2: Isolate Circuit.

- The next step during lamp replacement is to isolate the circuit by de-energizing the regulator, It may be necessary, due to runway access times, to change a bulb while the circuit is still energized. If you have to accomplish an energized bulb change, always wear rubber protective gloves and maintain safe body clearances.

Step 3: Remove the bolts that hold the fixture secure to the canister. The semi-flush units are secured to the pavement by bolts and slip rings. These slip rings allow the fixture to be aimed as necessary. Since we are interested in changing a bulb it will probably not be necessary to adjust the aiming of the fixture. But it's always wise to visually check the fixture's alignment when you know you will have it apart.

Step 4: Remove Fixture from Canister (semi-flush).

- With the bolts removed, you can now lift the fixture from the canister. It may be necessary to use the tip of a flat-tip screwdriver to pry the fixture upward since it is relatively heavy to be picking up with your finger tips.

SAFETY:
BE CAREFUL NOT TO PINCH YOUR FINGERS TRYING TO LIFT THE FIXTURE FROM THE CANISTER.

Step 5: Disconnect Leads (semi-flush).

- The PAR bulb is held in place in the fixture by three metal legs. There are several different means of securing the bulbs to the legs. One type has clips mounted on them. The bulb slips into these clips and is held in place by the spring tension of the clips. To remove the bulb from the fixture's legs, you must gently push the bulb toward the fixture's lens. Once the bulb has pushed free of the clips the bulb can be extracted from between the legs by twisting the bulb sideways and sliding it vertically between the legs.
- Another way of securing the bulb to the legs is to have a ring mounted on the end of the legs that clamps the bulb between it and another ring. The rings are held together with nuts that are easily operated using your fingers. To remove the top bulb, simply remove the nuts, take the outer ring off and lift the bulb off of the other ring. To disconnect the leads from the PAR lamp, it is necessary to loosen the two slotted screws securing the wires to the bulb using a flat-tip screwdriver.

SAFETY:
SOMETIMES THE SCREWS HOLDING THE WIRES FROM THE ISOLATING TRANSFORMER TO THE BULB HAVE RUSTED IN PLACE. BE CAREFUL THAT THE SCREWDRIVER DOES NOT SLIP. YOU MIGHT BREAK THE BULB OR JAM THE SCREWDRIVER INTO YOUR SELF.

Step 6: Replace Lamp (semi-flush).

NOTE:
When a lamp needs to be changed, DO NOT touch the new lamp with your bare hands. The oil on your skin will create a hot spot on the lamp and drastically reduce the life of the lamp.

- Once the burned out bulb is removed and disconnected, the next step is to replace the bulb with a new one. Make sure that the current rating and wattage of the replacement bulb are the same as the original bulb. Reconnect the leads to the lamp and reinsert the bulb between the legs. Secure the bulb so that it doesn't accidentally slip out.

Step 7: Install and Secure the Fixture (semi-flush).

- Lower the fixture into the canister. Be sure the lens of the fixture is pointing in the proper direction. Refer to the indicator arrows on top of the fixture to help ensure the fixture is properly aligned. Secure the fixture to the canister with the bolts that were previously removed.

Step 8: Check Operation (semi-flush).

- The last step in changing the bulb is to check the fixture for proper operation. If there are other bulbs to replace, change them prior to turning the power back on. This saves a lot of time. If not, re-energize the circuit and check the light for proper operation.

Replace Lamp (elevated fixture).

Step 1: Remove Lens Assembly (elevated fixture).

- The way you do this is dependent upon the way the lens is held onto the fixture. The two main types of lens securing apparatus are clips and rings. The clips are crescent shaped pieces of metal that need to be pushed over an edge of the lens lip and a raised ridge on the underside of the fixture's lens platform. The clip is held on by the tension necessary to spread it over the lips and ridges. To remove the clip, simply insert a flat-tip screwdriver between the clip and the fixture and twist the screwdriver until the clip slides off of the lens. There are normally four clips on each lens.
- The other method of securing the lens is to use a metal ring that overlaps the entire circumference of the lens lip and the circumference of the lens platform. The ring is snapped together with a loop and hook closure method. To remove the ring, simply snap the lever forward. This relieves tension on the loop that can then be slipped over the hook. Once free, the ring can be spread apart, slid upward over the lens lip, and over the rest of the lens. The lens can then be lifted away, exposing the bulb and electrical fixture for maintenance

NOTE:
The first steps in replacing a lamp in an elevated fixture are the same as those used to replace a bulb in a semi-flush fixture. You should coordinate control of the airfield with the tower and isolate the circuit.

NOTE:
When a lamp needs to be changed, DO NOT touch the new lamp with your bare hands. The oil on your skin will create a hot spot on the lamp and drastically reduce the life of the lamp. The procedures used depend upon the type of lamp the fixture uses.

Step 2: For a pre-focus lamp, remove the bulb by gently pushing down and twisting in a counterclockwise direction. Continue to turn the bulb until the tabs on the base of the

bulb align with the tab shaped slots in the base of the fixture. There are two tabs of different sizes on the bulb. The slots on the fixture are sized to correspond with the bulb's tabs.

NOTE:
Therefore, the bulb can only be removed if the proper tab is aligned with the correct slot.

Step 3: To install the new bulb into the socket, gently insert the base of the bulb into the socket, aligning the big tab with the big slot in the socket and the small tab with the small slot. Once aligned, push downward with a slight pressure until the tabs are below the lip of the socket and gently twist the bulb until it won't turn any farther.

Step 4: To remove a medium bi-post lamp, you need to loosen the screws that secure the lamp to the fixture. These are located on the base of the socket. A flat-tipped screwdriver is required to accomplish this. Once loosened, grasp the bulb and pull gently upward. The bulb should slide from the fixture with minimal resistance.

Step 5: To install the new bulb, simply reverse the procedure.

SAFETY:
BE CAREFUL TO PROPERLY ALIGN THE TWO PRONGS SO THEY SLIDE SMOOTHLY INTO THE HOLES IN THE BASE. DO NOT FORCE THE PRONGS IN OR YOU COULD BREAK THE BULB OR DAMAGE THE BASE.

Step 6: Tighten the setscrews on the base to prevent the bulb from accidentally popping out of the socket holes and to prevent arcing within the sockets.

Step 7: To remove a PAR bulb from the fixture, there are three clips that hold the bulb in place, which need to be rotated. Before rotating them, slightly loosen the screws in the middle of the clip first. Then rotate the clips approximately 180 degrees and the bulb should lift out. A PAR lamp is connected to an upright fixture with a plug that looks similar to a 110-volt electrical plug. The leads from the IL are disconnected from the lamp by unplugging them.

Step 8: To install a new bulb just plug the prongs on the backside of the bulb into the female receptacle from the IL. Be careful when aligning the tabs on the lip of the bulb with the slots in the edge of the fixture. They are positioned so there is only one correct position the bulb can rest in the fixture. Twist the rotating clips back over the edge of the bulb and tighten the retaining screws down.

Step 9: Install Lens Assembly (elevated fixture).

- After the lamp is replaced, install the lens assembly with steps opposite from those required in removal.

Step 10: Check Operation.

- Like the semi-flush fixture bulb changes, it is necessary to check the lamp for proper operation. To save time, complete all bulb changes prior to re-energizing the circuit

Review Questions
for
Airfield Light Lamps

Question	Answer
1. Which of the following IS NOT one of the type of lamps used on the airfield?	a. Pre-focused base b. Pre-focused bulb c. Medium BI-post d. Par lamp
2. Why is important not to handle new lamps with your bare hands or dirty gloves?	a. Prevent finger prints b. Prevent dulling lamps light c. Prevent hot spots d. Prevent leaking lamps
3. The first step in lamp replacement for a semi-flush fixture is to _____.	a. Coordinate control of airfield b. Remove fixture from canister c. Remove lens assembly d. Isolate circuit
4. When replacing a bulb in an airfield fixture, what parameters of the original bulb's classification do you need to check on the replacement bulb?	a. Wattage b. Amperage c. Voltage d. m and n They are rated in wattage, input amperage, and output amperage.

INSTRUCTIONS: Rearrange the replacement procedures into the correct sequence by placing the correct step number next to the procedure.

1. Replace semi-flush fixture lamp.
_____ Check operation
_____ Remove fixture from canister
_____ Coordinate control of airfield
_____ Isolate circuit
_____ Disconnect Leads
_____ Replace Lamp
_____ Remove bolts
_____ Install and secure the fixture

2. Replace elevated fixture lamp.
_____ Replace Lamp
_____ Coordinate control of airfield
_____ Check operation
_____ Remove lens assembly
_____ Install Lens Assembly
_____ Isolate circuit

AIRFIELD LIGHT LAMPS

Performance Checklist			
Step		**Yes**	**No**
1. Did the trainee know the necessary steps to replace a semi-flush fixture lamp?			
a.	Coordinate Control of Airfield		
b.	Isolate Circuit		
c.	Remove Bolts		
d.	Remove Fixture from Canister		
e.	Disconnect Leads		
f.	Replace Lamp		
g.	Install and Secure the Fixture		
h.	Check Operation		
2. Did the trainee know the necessary steps to replace an elevated fixture lamp?			
a.	Coordinate Control of Airfield		
b.	Isolate Circuit		
c.	Remove Lens Assembly		
d.	Replace Lamp		
e.	Install Lens Assembly		
f.	Check Operation		
3. Did trainee ensure that bare hands were not used while installing new lamps?			

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

REPLACE

MODULE 19 **AFQTP UNIT 10**

ISOLATING (IL) TRANSFORMERS (19.10.2.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

ISOLATING (IL) TRANSFORMERS

Task Training Guide

STS /Reference Number/Title:	19.10.2. – Airfield lighting systems, replace isolating (IL) transformers
Training References:	• AFI 32-1064, Electrical Safe Practices • CDC 34051B, Vol. 3
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Personal Protective Equipment • Flat-tipped screwdriver • Socket Set
Learning Objective:	• Given equipment, replace isolating (IL) transformers.
Samples of Behavior:	• Follow approved methods to replace isolating (IL) transformers • Know safety requirements associated with isolating Airfield lighting systems circuits and equipment
Notes:	
• To successfully complete this element the trainee must be able to isolate and replace Isolating (IL) Transformers. • Any violation of safe practices constitutes failure.	

ISOLATING (IL) TRANSFORMERS

Background: Usually during periodic visual inspections of airfield lighting system's there are discoveries of inoperative light fixtures. The majority of the time problems are related to a burned-out lamp, bad connections, or a bad IL transformer.

One characteristic of a series circuit is that when one lamp burns out, all the lamps in the circuit go out. To avoid this problem, an isolating transformer (IL) is used for each fixture in the circuit. The IL isolates each lamp from the circuit to ensure the circuit's continuous operation and to eliminate the hazard of exposing personnel to the series circuit high voltage. IL's are also used to match circuit amperage to the amperage of the bulb and to match transformer capability to the wattage of the bulb. Therefore, many different sizes of IL's are used.

There are three types of IL transformers: step-up, step-down and one-to-one. These transformers work on the same principle as a distribution transformer--mutual induction. The step-up IL has an input amperage of 6.6 amps and an output amperage of 20 amps. The step-down IL receives an input of 20 amps and steps it down to 6.6 amps. The one-to-one IL transformer's output amperage is the same as its input amperage (e.g. 20 amp/20 amp, 6.6 amp/6.6 amp).

Isolating transformers are rated in wattage, input amperage, and output amperage. The wattage and output amperage of the IL must match that of the lamp it will provide service to. The input amperage of the IL must match the circuit amperage or, in other words, the maximum current output of the constant current regulator feeding the circuit.

For example: the M-1 taxiway fixture uses a T-10 bulb rated at 30-watts/6.6 amp. Therefore, an IL rated at 30-45 watt and an secondary amperage of 6.6 amps would be used. The regulator likewise would provide 6.6 amps to the primary side of the transformer. The end result is that you would use a 6.6 amp/6.6 amp, 30-45 watt, a one-to-one transformer.

To perform the task, follow these steps:

Step 1: Coordinate control of airfield.

- Always coordinate with the tower for control of the airfield lighting system before starting to install an IL transformer. The IL transformers are connected in series with the circuit and like the power cable that feeds them, have an insulation value of 5,000 volts. They are connected to the power cable using connector kits.

SAFETY:
SERIOUS INJURY CAN RESULT IF THE CIRCUIT IS ENERGIZED DURING THE REMOVAL OR REPLACEMENT OF THE IL TRANSFORMER. REMEMBER THAT THE VOLTAGE WILL RISE EXTREMELY HIGH IF AN OPEN OCCURS IN THE SECONDARY SIDE OF AN IL TRANSFORMER. ALTHOUGH ALL OF THE STEPS MAY NOT HAVE TO BE DONE, NOTIFYING THE TOWER MUST BE ACCOMPLISHED BEFORE THE WORK CAN STARTED.

Step 2: Isolate Circuit.

- Before removing or installing an isolating transformer, be sure to isolate the circuit by de-energizing, tagging, and grounding the circuit.

Step 3: Locate IL.
- An IL transformer can be installed either below the light fixture in the canister or behind the fixture in a concrete trough. Either way, the steps for replacing an IL transformer are the same.

Step 4: Disconnect Secondary Leads.
- Remove the fixture and disconnect the secondary lead of the IL. The secondary lead is easily identified. It has two different sized connectors molded into the plug that goes to the light. To disconnect the lead, first remove the tape from the connectors and pull the plugs apart.

Step 5: Disconnect Primary Leads.
- Use a clamp on ammeter verify the circuit is de-energized.
- Remove the tape from each connector kit plug and then pull them apart.

Step 6: Remove and Replace Defective IL.
- Grab the wires, lift the whole transformer out of the hole, and discard.

Step 7: Connect Primary Leads.
- Reconnect the primary leads by inserting the male prong into the female receptacle. Be sure to slightly bend the connector kit while you are pushing the plug and receptacle together to let any air trapped inside to escape.

NOTE:
If you don't allow the air to escape, it could force the plugs apart allowing an incomplete union. This would result in total circuit failure. Be sure to always "burp" the plug. Don't forget to connect both the primary input and primary output side of the IL.

Step 8: Connect Secondary Leads.
- Like the primary leads, you will need to plug the secondary male and female plugs together. The male side of the plug has two prongs; one has a wider diameter than the other does. The female receptacle also has two different size holes that are the same size as the male prongs. This means that there is only one way that the plug can go together. The big prong to the big hole and small prong to the small hole.

NOTE:
Again, when connecting these leads, be certain to work as much air as possible out of the connection.

Step 9: Tape Connectors.
- Wrap the connectors with two half-lapped layers of vinyl plastic tape to prevent the connectors from separating and to keep moisture or dirt from entering the plug.

Step 10: Re-Install Fixture.
- Reinstall the fixture and energize the circuit to see if the fixture and IL operate properly.

Review Questions
for
Isolating (IL) Transformers

Question	Answer
1. How are isolating transformers rated?	a. Wattage b. Input amperage c. Output amperage d. All of the above
2. An isolating transformer (IL) is used for each fixture in the circuit, the IL isolates each lamp from the circuit to ensure the circuit's continuous operation and to eliminate the Hazard of exposing personnel to _____?	a. Series circuit high voltage b. Parallel circuit high voltage c. Fault current d. Stray voltage
3. Wrap the connectors with two half-lapped layers of vinyl plastic tape to prevent the connectors from separating and to keep ____ or _____ from entering the plug.	a. Insects, dirt b. Moisture, dirt c. Ground, dirt d. Moisture, Insects
4. Although all of the steps may not have to be done, notifying the tower must be accomplished before the work can be started.	a. True b. False

INSTRUCTIONS: Rearrange the replacement procedures into the correct sequence by placing the correct step number next to the procedure.

1. Replace isolating transformer
_____ Tape connectors
_____ Connect leads
_____ Coordinate control of airfield
_____ Locate IL
_____ Check operation
_____ Disconnect leads
_____ Remove and replace defective IL
_____ Re-install fixture
_____ Isolate circuit

ISOLATING (IL) TRANSFORMERS

Performance Checklist			
Step		**Yes**	**No**
1. Did the trainee know the necessary steps to replace an IL transformer?			
a.	Coordinate Control of Airfield		
b.	Isolate Circuit		
c.	Disconnect Secondary Leads		
d.	Disconnect Primary Leads		
e.	Remove and Replace Defective IL		
f.	Connect Secondary and primary Leads		
g.	Tape Connectors		
h.	Re-Install Fixture		
2. Did the trainee recognize any safety concerns with replacing an IL transformer?			

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

TROUBLESHOOT

MODULE 19 AFQTP UNIT 11

AIRFIELD LIGHTING CIRCUITS (19.11.1.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

AIRFIELD LIGHTING CIRCUITS

Task Training Guide

STS Reference Number/Title:	19.11.1. – Airfield lighting systems, troubleshoot airfield lighting circuits
Training References:	• AFI 32-1044, Visual Air Navigation Systems • AFP 91-28, Maintenance of Airfield Lighting Systems • T.O.'s 35F5-3-12-1, 35F5-4-2-1 • CDC 3E0X1B, Vol. 3
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Megger • Clamp-on Ammeter • Cable fault locator • Handtools • Protective equipment
Learning Objective:	• Given equipment, troubleshoot airfield lighting circuits
Samples of Behavior:	• Follow approved methods to troubleshoot airfield lighting circuits • Know safety requirements associated with troubleshooting airfield lighting circuits
Notes:	
• Any safety violation is an automatic failure.	

AIRFIELD LIGHTING CIRCUITS

Background: One way a fault can be found in an airfield lighting circuit is by using a megger, a clamp-on ammeter, and a cable fault locator. The megger will be used to find the section of the circuit where the fault is located. The cable fault locator can then be used to locate the specific spot where the fault is so the fault can be repaired or that section of wire replaced. The clamp-on ammeter will be used to locate ungrounded shorts in the cable.

To perform the task, follow these steps:

Step1: Notify tower.

- To begin troubleshooting, you will take control from the control tower and isolate the circuit.
- The circuit is isolated by first isolating the regulator and then disconnecting the circuit.
- Now use the megger to determine whether a ground, short, or an open exists.

Step 2: Determine fault condition and locate faulted area.

- If an open exists, ground both ends of the circuit in the vault.
- Go to the midpoint of the light circuit, break it, and megger from the wire to the ground.
- If the megger reads zero, that part of the circuit is good.
- If the megger reads infinity, that part of the circuit is bad.
- Now ground the end of the bad section of cable.
- Go to the midpoint of the section of cable that gave a bad reading and continue this process until you are in a small enough section for your cable fault locator to operate in (determined by the type of cable fault locator).

NOTE:
When ungrounded shorts are present, make an initial analysis by energizing the circuit and visually determining which lights are operating. Then, further isolate the fault by using a clamp- on ammeter.

- Select a test point at the start of one feeder and progress systematically through the field circuit.
- Connect the ammeter around the conductor of the circuit.
- Energize the circuit with the regulator and read the current in the circuit at the test point.

SAFETY:
DO NOT COME IN CONTACT WITH THE CABLE OR METER WHILE THE CIRCUIT IS ENERGIZED. IF THE METER MUST BE HANDLED OR ATTACHED TO THE CIRCUIT WHILE THE CIRCUIT IS ENERGIZED, USE THE INSULATED TONG ASSEMBLY.

- If the current in the circuit at the test point is approximately normal, the short is located beyond the test point.
- If the current in the circuit at the test point is very low or zero, the short is between the test point and the regulator.
- Continue moving the test point forward in the circuit until the fault in located.
- If your original megger readings determined that you had a ground fault, position the ends of the circuit so that they are in the open and not touching anything.

- Now you will go to the midpoint of the circuit and check it with the megger between the wire and ground.
- If the megger reads infinity, that section of the circuit is good.
- If the megger reads zero, that section of the circuit is bad.
- Leave the end of the bad section of cable in the open.
- Go to the midpoint of that section of cable and repeat the procedure until you are in a small enough section for your cable fault locator to work.

SAFETY:
CARE MUST BE TAKEN WHEN TROUBLESHOOTING AIRFIELD LIGHTING CIRCUITS, BECAUSE OF THE POSSIBILITY OF ONE CIRCUIT BURNING INTO ANOTHER AND THE CLOSE PROXIMITY OF CIRCUITS. ALSO, CARE MUST BE TAKEN TO NEVER PUT TEST EQUIPMENT ON ENERGIZED CIRCUITS. TREAT AN UNKNOWN CIRCUIT AS IF ENERGIZED UNTIL IT CAN BE PROVEN IT IS OTHERWISE.

Review Questions
for
Airfield Lighting Circuits

Question	Answer
1. An infinite reading on the megger while troubleshooting for an open indicates that the circuit is _____.	a. The circuit is closed. b. The circuit is open. c. The circuit is shorted. d. None of the above
2. When troubleshooting an airfield lighting circuit, what is the megger primarily used for?	a. To locate ungrounded shorts in the cable. b. To locate the specific spot where the fault is located. c. To locate the section of cable where the fault is located. d. A and C
3. Which meters are used to troubleshoot for ungrounded shorts in an airfield lighting circuit?	a. Megger b. Cable fault locator c. Clamp-on ammeter d. All of the above
4. When troubleshooting an airfield lighting circuit, what is the cable fault locator used for?	a. To locate ungrounded shorts in the cable. b. To locate the specific spot where the fault is located. c. To locate the section of cable where the fault is located. d. A and C.
5. When testing for a ground fault in a circuit, what will a reading of infinity tell you?	a. The cable is good. b. The cable is bad
6. What is the first thing done when working on the airfield?	a. Isolate the cable b. Ground the cable ends c. Notify tower d. Meg the cable to locate faulted section.

AIRFIELD LIGHTING CIRCUITS

Performance Checklist		
Step	**Yes**	**No**
1. Did the trainee notify the tower?		
2. Was the trainee able to locate faults in the cable?		
3. Was the trainee able to determine the type of fault?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

AIRFIELD LIGHTING SYSTEMS

MODULE 19 **AFQTP UNIT 12**

REPAIR AIRFIELD LIGHTING CABLE (19.12.)

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

REPAIR AIRFIELD LIGHTING CABLE

Task Training Guide

STS /Reference Number/Title:	19.12. – Airfield lighting systems, repair airfield lighting cable
Training References:	• AFP 91-28, Maintenance of Airfield Visual Aid Facility • 33A1-3-102-1, Test Set, Airfield Lighting Systems • AFMAN 32-1064, Electrical Safe Practices • CDC 3E051B
Prerequisites:	• Possess as a minimum a 3E031 AFSC
Equipment/Tools Required:	• Personal Protective Equipment • Testing Set • Crimping Tool • Hand Tools
Learning Objective:	• Given equipment, repair airfield lighting cable
Samples of Behavior:	• Follow approved methods to repair airfield lighting cable. • Know safety requirements associated with repairing airfield lighting cable
Notes:	
• To successfully complete this element, the trainee must be able to identify proper procedures to repair airfield lighting cable using cable splicing specifications with no major discrepancies that which classifies the repair as unserviceable, or safety violations. • Any major discrepancies or safety violation constitute failure.	

REPAIR AIRFIELD LIGHTING CABLE

Background: Airfield cable used between the lighting vault and the lights that it controls, it is necessary for you to understand the fundamentals of cable repair. There are basically two types of splices used on airfield lighting circuits: permanent splice kits and connector kits. When a splice is to be made on airfield cable, choose the right kit for the job and follow all instructions carefully. Permanent splices are used to join cables in areas that are subject to moisture and locations not requiring separation for connecting components or testing. Connector kits are used in areas requiring quick connection and disconnects for components and for testing. Splices made on airfield cable must be electrically and mechanically as strong as the cable itself. Airfield lighting cable is rated at 5,000 volts; therefor any splice kit used on any airfield lighting system must be rated for 5 KV.

To perform the tasks, follow the steps below:

Step 1: Isolate circuit.

- Ensure that the lighting circuit has been isolated and can not be energized in any way.

Step 2: Replace defective section of cable.

- Locate the defective section of airfield cable and replace with new.

NOTE:
The replacement of cable could take longer at different location. Some cable is direct buried while others are in conduit. The replacement methods will be different for each type of system, however the splicing of the cable will remain the same.

Step 3: Determine splicing method.

- Determine the type of splice to be used.

NOTE:
To determine the type of splice needed you should ask yourself these questions:

1. Is the splice going to be buried or in a manhole?
2. Is the location of the splice going to be in or around moisture?
3. Do I need to be able to add other items to the circuit now or in the future?
4. Would this make a good test point for troubleshooting?

Permanent splice kits.

- Many manufacturers make splicing kits for airfield applications. You normally will find the following in a splice kit: cable body molds, insulating resin, high voltage tape, and an instruction sheet. To complete the splice, you will need to supply the connector of the correct size (usually #8 for airfield cable).

Step 1: Prepare cable.

- Thoroughly remove all wax and dirt from the cable jacket for a minimum of 12 inches down the cable from the end.
- Remove insulating material from the conductor for 1/2 the length of the connector plus 1/4 of an inch.
- Prepare cable ends in accordance to manufacturers specifications.

SAFETY:
CARE SHOULD BE EXERCISED WHILE USING A KNIFE TO STRIP THE CABLES INSULATION FROM THE CONDUCTOR. ALWAYS PUSH THE KNIFE AWAY FROM YOUR BODY, BUT NOT TOWARD COWORKERS.

NOTE:
- The insulation may be stripped by using a stripping tool if used use one designed for your cable and of the correct diameter for your cable.
- Penciling may be accomplished by means of a penciling tool, if used care needs to be taken to use the properly sized tool for the size of wire.

Step 2: Make Connection.
- Place connector on end of one wire and crimp using crimping tool.
- Join the two cables by placing the second wire into the connector and crimping with tool.

SAFETY:
CARE SHOULD BE TAKEN NOT TO PINCH FINGERS IN THE CRIMPING TOOL. SOME CRIMPIMG TOOLS WILL NOT RELAESE UNTIL IT HAS BEEN CLOSED ALL THE WAY.

NOTE:
When selecting the connector, be sure to select one that is compatible with your cables. One that is of the same material as the wire (copper or aluminum).

Step 3: Tape connector.
- Apply one layer, half lapped, "high voltage rubber tape" over connector and any exposed wire.

Step 4 Install molded body.
- Trim molded body ends with knife to fit cable insulation snugly.
- Center over the splice.
- Snap molded halves firmly together.
- Check to see that both seams are completely snapped together.

NOTE:
The use of pliers many be needed to snap the two halves together, however care should be taken not to break the mold.

Step 5: Tape Ends of Mold.
- Tape ends of mold to seal around cable.
- Use high voltage tape supplied with kit; if not provided use plastic tape.

Step 6: Pour resin. (Figure 1)
- Place the pouring spouts into the mold body.
- Position splice level.
- Mix resin thoroughly per instructions.
- Pour resin immediately after mixing.
- Fill mold through one spout until both spouts are completely filled.
- Tap mold lightly to remove air bubbles in resin.

NOTE:
Do not energize circuit until resin has solidified and cooled.

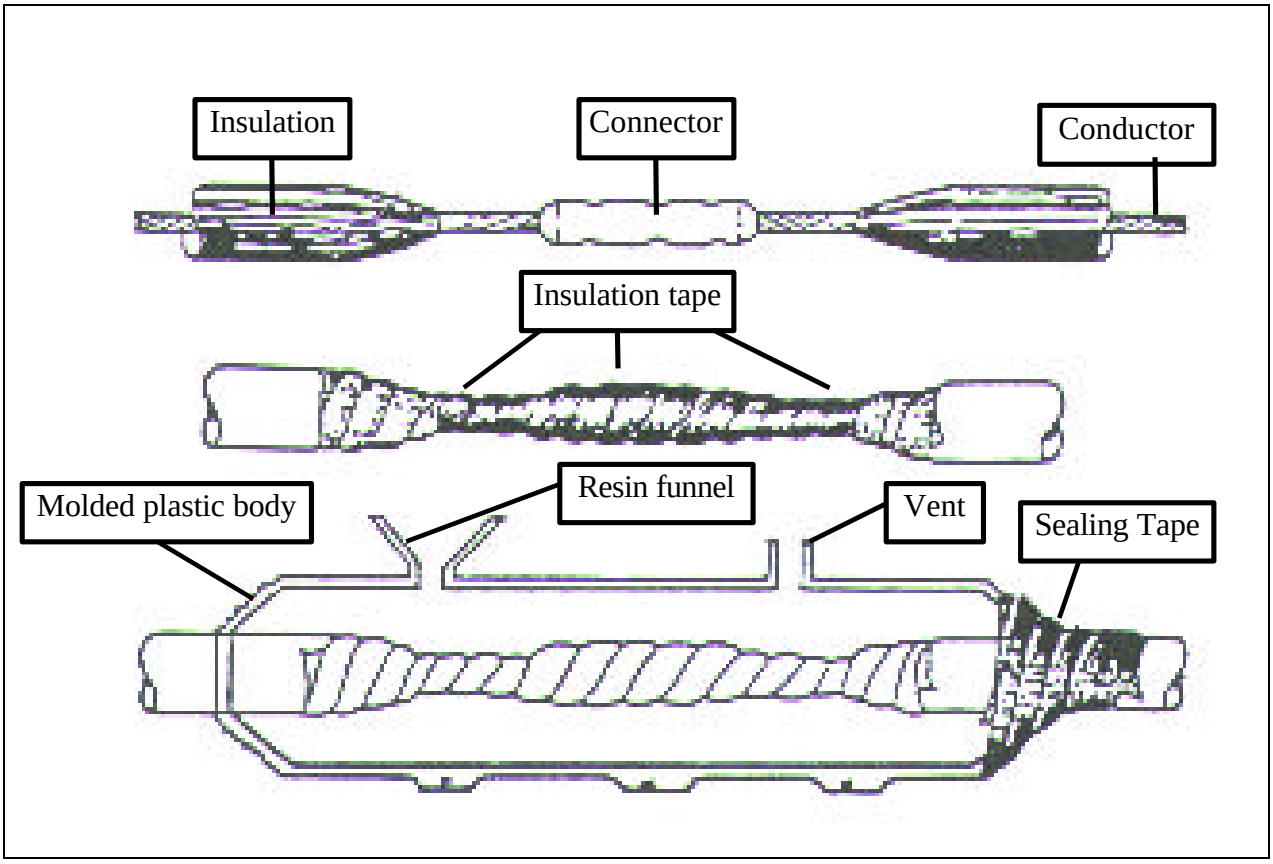


Figure 1, A resin splice.

Connector Kit.

- Connector kits, also known as a Joy splices, are used to make a splices in cables for testing points or as an attachment point for isolation transformers. These kits contain two molded rubber bodies, two polarized pins, a wiping cloth, and an instruction sheet. Follow the instructions to remove insulation, pencil insulation, crimp pin, and sliding the molded body onto the cable. With these simple procedures, you have completed a 5,000V splice suitable for use on an airfield lighting system. Upon completion of a joy splice, apply two layers of plastic tape around the joint. These kits come in different cable insulation sizes and should be selected for the type and diameter of the cable it will be used on. Typical joy splice assembly instructions are as follows (Figure 2):

Step 1: Clean cable ends.

- Thoroughly clean portions of cable to be inserted into housing for at least 12 inches from the end of the cable.
- Keep all connector parts clean**.**

NOTE:
When picking the rubber molded splice or joy splice, the type and size for your cable should be used. If your cable is a shielded type cable use the shield type joy splice.

Step 2: Strip conductor ends.

- Strip insulation from conductor as described in the instructions or approximately 3/4 of an inch.

SAFETY:
CARE SHOULD BE EXERCISED WHILE USING A KNIFE TO STRIP THE INSULATION FROM THE CONDUCTOR. ALWAYS PUSH THE KNIFE AWAY FROM YOUR BODY, BUT NOT TOWARD COWORKERS.

NOTE:
The insulation may be stripped by using a stripping tool if used use one designed for your cable and of the correct diameter for your cable.

Step 3: Penciling.

- Taper the jacket and insulation starting 1 inch away from the connector point and working toward the end of the wire.

NOTE:
Penciling may be accomplished by means of a penciling tool, if used care needs to be taken to use the properly sized tool for the size of wire.

Step 4: Connectors.

- Place one connector on one of the cable ends and crimp with tool.
- Place second connector on the second cable end and crimp with tool.

SAFETY:
CARE SHOULD BE TAKEN NOT TO PINCH FINGERS IN THE CRIMPING TOOL. SOME CRIMPING TOOLS WILL NOT RELAESE UNTIL IT HAS BEEN CLOSED ALL THE WAY.

Step 5: Molded ends.

NOTE:
The connectors and molded rubber splice bodies are in sets one female set and one male set. These can not be interchanged with one another. They will not work.

- Place the male molded rubber splice onto the male connector and remove, this will leave a small amount of silicone grease on the connector.
- Spread the grease along the connector and wire insulation about 2 inches away from the connector.
- Insert in connector back into the molded rubber splice and push until it protrudes from end of the splice about 1 1/2 inch.
- Wipe the silicone grease that comes out of the male end on to the connector and wire of the female connector.

NOTE:
Do not push the female connector in to the female splice to get the silicone grease. If this is done the depth gage will come off when removed.

- Insure that the depth gage is in place on the connector and seating gage is in place on the splice.
- Insert the female connector into the female splice until the ring on the depth gage is even with the end of the seating gage.
- Remove excess silicone grease with clean wiper cloth.

Step 6: Connect splice ends.

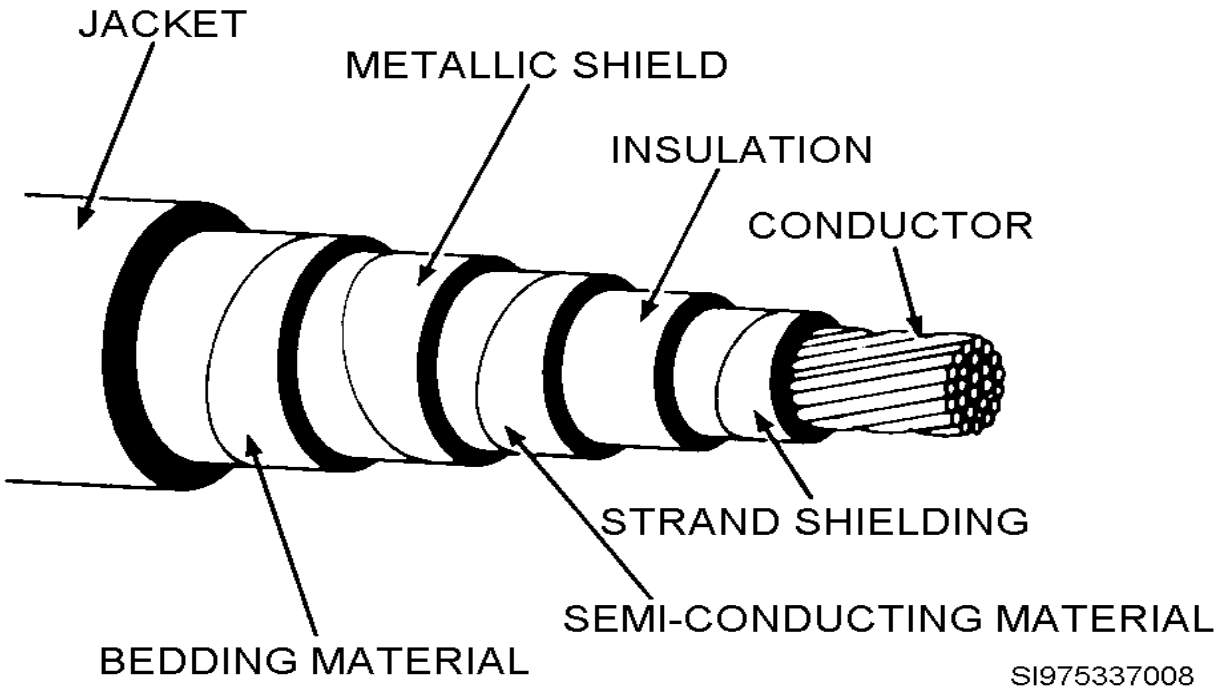
- Complete electrical connection by inserting plug into receptacle.

Step 7: Tape splice.

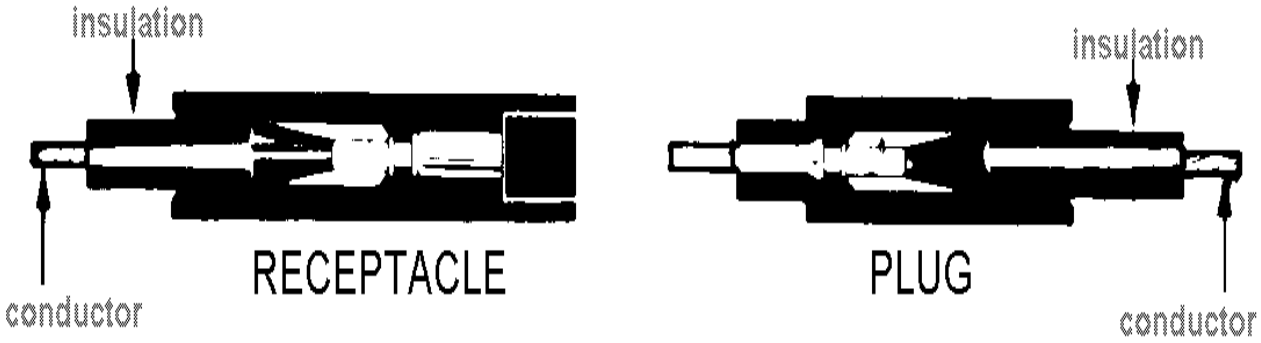
- Tape the joint where molded rubber splices come together it should be wrapped with at least two layers of plastic tape, 1/2 lapped, extending 1-1/2 on inches on each side of the joint. No other taping is required.

Step 8: Test circuit:

- Complete all remaining splices ensuring the circuit is connected.
- At the Lighting Vault connect an ohm meter to the circuit (may need to use a meg-ohm meter) and verify that circuit is completed.
- Reconnect the regulator to the circuit.
- Using approved procedures reconnect the regulator to the control and power circuits.
- Have tower turn on circuit or follow approved procedures to turn on circuit your-self.



SHIELDED CABLE



NON-SHIELDED CABLE

Figure 2, Shielded and Non-Shielded cable.

Review Questions
for
Repair Airfield Lighting Cable

Question	Answer
1. At what voltage are airfield lighting cables rated?	a. 2KV b. 4KV c. 5KV d. 7.5KV
2. What is the first step in making a splice on airfield lighting cable?	a. clean cable b. strip insulation c. test for voltage d. isolate the circuit
3. The two basic types of splices are the permanent and the _____.	a. high voltage tape b. connector kit c. temporary d. crimp
4. How many layers of tape are put on the connector in a permanent splice?	a. one b. two c. three d. four
5. What can be used to trim the plastic molded body halves?	a. knife b. razor blade c. screwdriver d. pliers
6. Fill the plastic molded splice until the resin is full in both the fill and the vent.	a. True b. False
7. Connector kits can not be taken apart to make system checks.	a. True b. False
8. After the rubber molded connectors are put together tape is wrapped around the mid-point and the end of the connectors where cable enters.	a. True b. False
9. After all splices are completed you should _____.	a. bury the cable b. clean the area c. energize circuit d. See if the circuit is complete.

REPAIR AIRFIELD LIGHTING CABLE

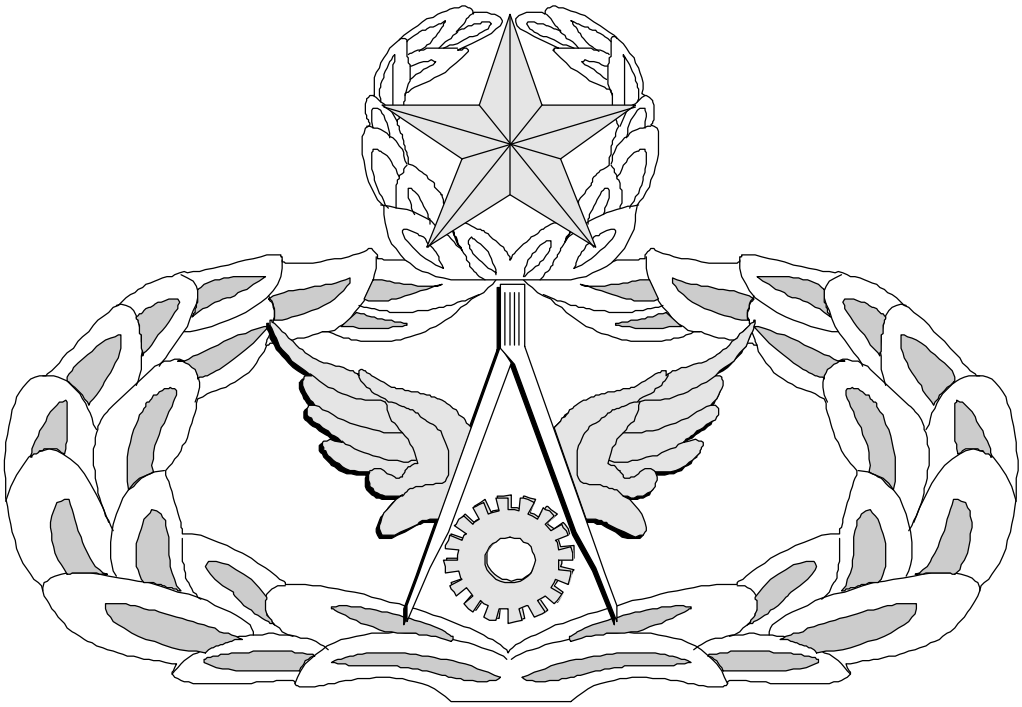
Performance Checklist		
Step	**Yes**	**No**
1. Did the trainee determine the proper splicing method for the repair?		
2. Was the trainee able to fabricate a permanent splice?		
3. Was the trainee able to fabricate a connector kit?		
4. Did the trainee tape all joints?		
5. Did the trainee test circuit with an ohmmeter or megohmmeter?		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

Air Force Civil Engineer

QUALIFICATION TRAINING PACKAGE (QTP)

REVIEW ANSWER KEY



For

ELECTRICAL SYSTEMS

(3E0X1)

MODULE 19

AIRFIELD LIGHTING SYSTEMS

Notice. This AFQTP is *NOT* intended to replace the applicable technical references nor is it intended to replace hands-on training if equipment is available. It is to be used in conjunction with these for training purposes only.

AIRFIELD LIGHTING SYSTEM COMPONENTS

(3E0X1-19.2.1.)

Question	Answer
1. Control components provide remote operation capabilities of airfield lighting.	a. True
2. What are the locations of the primary and secondary control points of the airfield lighting control system?	c. Cab of control tower and airfield lighting vault.
3. What compensates for the voltage drop from the tower to the vault?	a. Low burden pilot relay
4. Name the two inputs of a constant current regulators used in airfield lighting.	b. X1 and X2
5. What are constant current regulators rated by?	d. All of the above
6. What prevents airfield lighting series circuits from going out when one lamp burns out?	c. Isolating transformers
7. What is the purpose of the slip ring in the semi-flush light fixture?	d. Aligns the fixture with the centerline.

CONSTANT CURRENT REGULATOR

(3E0X1-19.4.1.)

Question	Answer
1. What must be accomplished before any maintenance is done on the regulators?	a. Notify tower
2. Control power for both high and low voltage regulators comes from _____.	c. Fuse and relay
3. What is used to clean a relay with silver contacts?	d. Use either crocus cloth or burnishing tool
4. What is the minimum size wire that can be used to jumper the output terminals when performing a short-circuit test?	d. #10 AWG
5. At what voltage is the mineral oil tested?	d. 22KV
6. On regulators with an open-circuit protection device how long does the open have to be present before it should operate?	c. 2 seconds
7. When isolating the regulator, and you have blocked, tagged and removed the X1 and X2 cables, what should you do next?	c. Ground the output terminals
8. What should you do when you notice that the input voltage present on the X1 and X2 terminals is lower than the previous months reading?	c. Notify the electrical supervisor
9. When disconnecting the H1 and H2 you should _____?	e. All of the above

CONTROL COMPONENTS

(3E0X1-19.4.2.)

Question	Answer
1. Before any work can be done on control components, the _____ must be notified and control taken in the vault.	c. Tower
2. A fine _____ is best for cleaning silver contacts.	b. Burnishing tool
3. Any time any work is performed on electrical circuits, whether energized or not, all _____ must be removed.	d. Jewelry
4. Contact should be cleaned at least _____.	d. Annually
5. When troubleshooting circuits, ALWAYS begin at the control power source, usually at the circuit breaker panel.	a. True

FIXTURES

(3E0X1-19.4.4.)

Question	Answer
1. When working on the airfield lighting system, you should always coordinate with the control tower.	a. True
2. Elements that have an adverse effect on airfield fixtures are _____.	e All of the above
3. There are many different systems of lights used on the airfield.	a. True
4. Constantly check the lighting system for conditions which could cause the system to fail.	a. True
5. The runway cable insulation resistance (meg-ohm) check should be done_____.	d. Annually
6. Because of ground settling, fixture repairs, and new fixture installation, fixtures must be aligned to ensure maximum efficiency.	a. True

APPROACH PATH INDICATORS

(3E0X1-19.4.9.)

Question	Answer
1. The key to keeping approach path indicators operating properly is regular _____.	a. maintenance
2. VASI lamps and filters need to be cleaned _____.	c. monthly
3. Check the leveling and operation of the VASI tilt switch?	c. monthly
4. Check insulation resistance of VASI underground cables and record the results _____.	d. semiannually
5. A PAPI system consists of _____ identical light units (FAA Type L-880).	b. 4
6. Normally PAPI light units are placed on the left side of the runway and provide the aircraft pilot approaching the runway with the correct glide slope.	a. True
7. A PAPI unit contains two or three projector modules.	a. True
8. Inspect PAPI units for burned-out bulbs _____.	a. daily
9. PAPI lens, filters, and reflectors need to be cleaned and inspected _____.	b. weekly
10. During monthly checks the tilt switch system needs to be tested by pulling on the tilt switch cord. The system should not stay on for more than _____ seconds.	c. 30
11. Remove dust buildup from PAPI power supply and unit semiannually.	a. True
12. PLASI is a ground installed, self contained, device that is housed in a single box.	a. True
13. There are two checks that are needed with the PLASI system, they are _____.	c. semiannual and unscheduled
14. During PLASI semiannual checks you must always turn the power off before you open the housing.	a. True
15. When changing PLASI lamps do not touch the lamps with your bare fingers?	a. True

ISOLATE AIRFIELD LIGHTING CIRCUITS OR EQUIPMENT FOR TEST

(3E0X1-19.5.)

Question	Answer
1. Why is it necessary to contact the tower before taking control of the light panel?	d. To get permission to take control
2. How many voltage inputs does a constant current regulator have?	b. Two
3. To disconnect the power source to the piece of equipment just pull the fuse cut out.	b. False, must check fuses, circuit breakers and control devices
4. To check a piece of equipment for power you must.	d. All the above.
5. Why is blocking and tagging important?	c. It lets others know that the equipment is being worked on.
6. Why should grounds be used?	d. They keep other circuits from inducing currents onto to circuit being worked on

CONNECT AIRFIELD LIGHTING CONSTANT CURRENT REGULATOR FOR EMERGENCY OPERATION

(3E0X1-19.9.)

1. To connect a regulator for emergency operation you should_____ the secondary cables.	b. Series
2. Connecting step 5 relay to _____ relay will keep regulator from overloading.	c. Step 4
3. It is not necessary to notify tower of emergency regulator connections because all airfield lights work.	b. False

Airfield Light Lamps
(3E0X1-19.10.1.)

Question	Answer
1. Which of the following IS NOT one of the type of lamps used on the airfield?	b. Pre-focused bulb
2. Why is important not to handle new lamps with your bare hands or dirty gloves?	c. Prevent hot spots
3. The first step in lamp replacement for a semi-flush fixture is to _____.	a. Coordinate control of airfield
4. When replacing a bulb in an airfield fixture, what parameters of the original bulb's classification do you need to check on the replacement bulb?	d. A and B They are rated in wattage, input amperage, and output amperage.

INSTRUCTIONS: Rearrange the replacement procedures into the correct sequence by placing the correct step number next to the procedure.

1. Replace semi-flush fixture lamp
   - 8 Check operation
   - 4 Remove fixture from canister
   - 1 Coordinate control of airfield
   - 2 Isolate circuit
   - 5 Disconnect Leads
   - 6 Replace Lamp
   - 3 Remove bolts
   - 7 Install and secure the fixture

2 Replace elevated fixture lamp
   - 4 Replace Lamp
   - 1 Coordinate control of airfield
   - 6 Check operation
   - 3 Remove lens assembly
   - 5 Install Lens Assembly
   - 2 Isolate circuit

ISOLATING (IL) TRANSFORMERS

(3E0X1-19.10.2.)

Question	Answer
1. How are isolating transformers rated?	d. All of the above
2. An isolating transformer (IL) is used for each fixture in the circuit, the IL isolates each lamp from the circuit to ensure the circuit's continuous operation and to eliminate the Hazard of exposing personnel to _____.	a. Series circuit high voltage
3. Wrap the connectors with two half-lapped layers of vinyl plastic tape to prevent the connectors from separating and to keep _____ or _____ from entering the plug.	b. Moisture, dirt
4. Although all of the steps may not have to be done, notifying the tower must be accomplished before the work can be started.	a. True They are rated in wattage, input amperage, and output amperage.

INSTRUCTIONS: Rearrange the replacement procedures into the correct sequence by placing the correct step number next to the procedure.

1. Replace isolating transformer
   - 7 Tape connectors
   - 6 Connect leads
   - 1 Coordinate control of airfield
   - 3 Locate IL
   - 9 Check operation
   - 4 Disconnect leads
   - 5 Remove and replace defective IL
   - 8 Re-install fixture
   - 2 Isolate circuit

AIRFIELD LIGHTING CIRCUITS

(3E0X1-19.11.1.)

Question	Answer
1. An infinite reading on the megger while troubleshooting for an open indicates that _____.	b. The circuit is open.
2. When troubleshooting an airfield lighting circuit, what is the megger primarily used for?	c. To locate the section of cable where the fault is located.
3. Which meters are used to troubleshoot for ungrounded shorts in an airfield lighting circuit?	d. All of the above
4. When troubleshooting an airfield lighting circuit, what is the cable fault locator used for?	b. To locate the specific spot where the fault is located.
5. When testing for a ground fault in a circuit, what will a reading of infinity tell you?	a. The cable is good.
6. What is the first thing done when working on the airfield?	c. Notify tower

REPAIR AIRFIELD LIGHTING CABLE

(3E0X1-19.12)

Question	Answer
10. At what voltage are airfield lighting cables rated?	c. 5KV
11. What is the first step in making a splice on airfield lighting cable?	d. Isolate the circuit.
12. The two basic types of splices are the permanent and the _____.	b. Connector kit.
13. How many layers of tape are put on the connector in a permanent splice?	a. One
14. What can be used to trim the plastic molded body halves?	a. Knife
15. Fill the plastic molded splice until the resin is full in both the fill and the vent.	a. True
16. Connector kits can not be taken apart to make system checks.	b. False
17. After the rubber molded connectors are put together tape is wrapped around the mid-point and the end of the connectors where cable enters.	b. False
18. After all splices are completed you should _____.	d. See if the circuit is complete.